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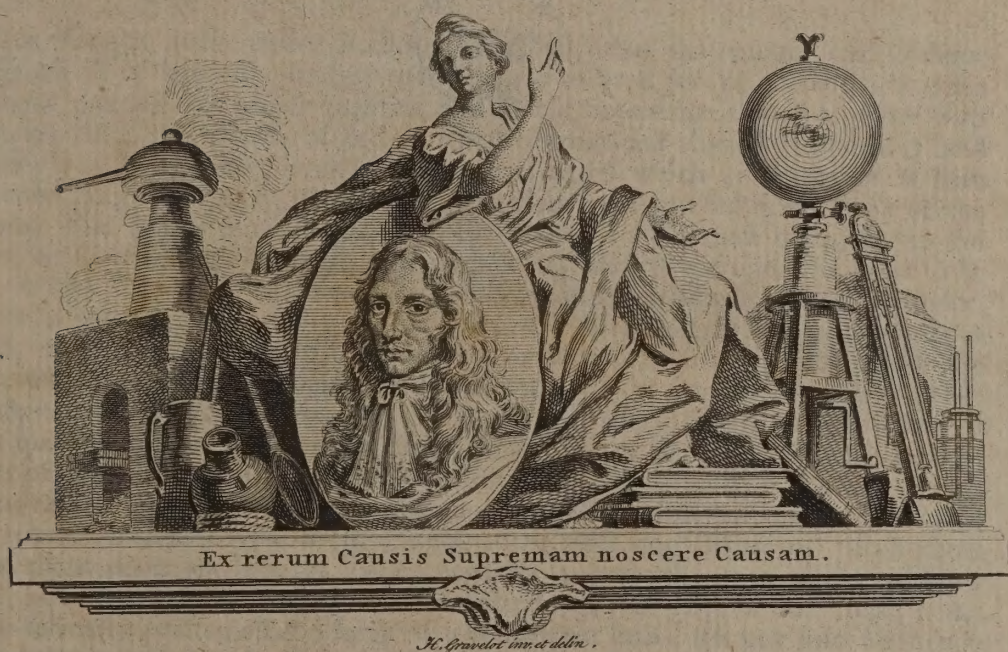
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THE
WORKS
OF THE HONOURABLE
ROBERT BOYLE.
In SIX VOLUMES.

To which is prefixed
The LIFE of the AUTHOR.

VOLUME THE FIFTH.

A NEW EDITION.



H. Gravelot inv. et delin.

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Dec 6 1796

A N
E S S A Y
O F T H E
G R E A T E F F E C T S
O f e v e n L A N G U I D a n d U N H E E D E D
M O T I O N.

Whereunto is annexed,

An EXPERIMENTAL DISCOURSE of some little observed Causes of the
INSALUBRITY and SALUBRITY of the AIR and its Effects.
[Being part of an intended NATURAL HISTORY of the AIR.]

ADVERTISEMENT of the PUBLISHER.

IT is thought fit the reader should be informed, that the ensuing tract (about the effects of languid motions) was designed to be a part of the author's notes about the origin of occult qualities, and should have come abroad together with the papers about the effluvia of bodies (most of which are already published;) and accordingly it was printed seven or eight years ago: which circumstance is here mentioned, to give a reason, why several particulars were omitted in the body of the discourse, that will be found annexed to the end of it: for these occurring to the author, whilst he cursorily read over the tract itself, when it was upon the point to be made publick, it was thought fit rather to subjoin them by way of a short appendix, than to let any thing be lost, that seem'd pertinent to so difficult and uncultivated a subject, as that they belong to. The reader is farther to be advertised, that of the three preliminary discourses, which the author intended for introductory ones to what he designed to say more particularly about the mechanical origin or production of occult qualities, one was concerning the relations betwixt the pores of bodies and the figures of corpuscles: but that the great intricacy and difficulty he found in this copious subject made him consent, that the discourse of local motion, which should have accompanied it to the press, should be printed long before it. And those papers about pores and figures having been for a great while out of the author's power, he now to gratify the stationer with something, that may, in their stead, make up the formerly printed essay a book of a convenient bulk, has put into his hands what now comes forth, about some unheeded causes of the healthfulness and insalubrity of the air; which being chiefly attributed to subterranean steams, subtil and for the most part invisible, are as near of kin to the other effluvia treated of in the introductory discourse, as is requisite to keep the mention, that is made of them in this book, from appearing very incongruous.

An ESSAY of the GREAT EFFECTS of even LANGUID and UNHEEDED LOCAL MOTION.

Y A C H A P. I.

HOW superficially soever the local motion of bodies is wont to be treated of by the schools, who admit of divers other motions, and ascribe almost all strange things in physicks to substantial forms and real qualities; yet it will become us, who endeavour to resolve the phænomena of nature into matter and local motion, (guided, at the beginning of things, immediately, and since regulated, according to settled laws, by the great and wise author of the universe,) to take a heedful notice of its kinds and operations, as the true causes of many abstruse effects. And though the industry of divers late mathematicians and philosophers have been very laudably and happily exercised on the nature and general laws of this motion; yet I look upon the subject, in its full extent, to be of such importance, and so comprehensive, that it can never be too much cultivated, and that it comprises some parts, that are yet scarce cultivated at all. And therefore I am not sorry to find myself obliged, by the design of these notes, (written, as you know, to facilitate the explicating of occult qualities) to endeavour to improve some neglected corners of this vast field, and to consider, whether, besides those effects of local motion, which are more conspicuous, as being produced by the manifest striking of one body against another, where the bulk, &c. of the agent, together with its celerity, have the chief interest; there may not be divers effects, wont to be attributed to occult qualities, that yet are really produced by faint or unheeded local motions of bodies against one another, and that oftentimes at a distance?

But, before I enter upon particulars, this I must premise in general, (which I have elsewhere had occasion to note to other purposes,) that we are not to look upon the bodies we are conversant with, as so many lumps of matter, that differ only in bulk and shape, or that act upon one another merely by their own distinct and particular powers; but rather as bodies of peculiar and differing internal textures, as well as external figures: on the account of which structures many of them must be considered as a kind of engines, that are both so framed and so placed among other bodies, that sometimes agents, otherwise invalid, may have notable operations upon them; because those operations being furthered by the mechanism of the body wrought on, and the relation, which other bodies and physical causes have to it, a great part of the effect is due, not precisely to the external agent, that it is wont to be ascribed to, but in great measure to the action of one part of the body itself (that is wrought on) upon another, and assisted by the concurring action of the neighbouring bodies, and perhaps of some of the more catholick agents of nature. This notion or consideration being in other papers particularly confirmed, I shall not now insist upon it, trusting, that you will not forget it, when there shall be occasion to apply it in the following notes.

THERE may be more accounts, than we have yet thought of, upon which local motions may perform considerable things, either without being much heeded, or without seeming other than faint, at least in relation to the considerableness of the effects produced by them. And therefore I would not be understood in an exclusive sense, when in the following discourse I take notice but of a few of the above-mentioned accounts; these seeming sufficient, whereto, as to heads, may be conveniently enough referred the instances I allot to this tract.

AND

AND concerning each of these accounts, I hold it requisite to intimate in this place, that I mention it only, as that, whereon such effects of local motion, as I refer to it, do principally depend : for otherwise I am so far from denying, that I assert, that in divers cases there are more causes than one, or perhaps than two of those here treated of apart, that may notably concur to phænomena directly referred to but one or other of them.

To come then closer to our subject, I shall take notice, that among the several things, upon whose account men are wont to overlook or undervalue the efficacy of local motions, that are either unheeded or thought languid, the chief, or at least those, that seem to me fittest to be treated of in this paper, are those, that are referrible to the following observations.

C H A P. II.

O B S E R V A T I O N I.

Men are not usually aware of the great efficacy of celerity, even in small bodies, and especially if they move but through a small space.

WHAT a rapid motion may enable a body to do, may be judged by the powerful and destructive effects of bullets shot out of cannons, in comparison of the battering engines of the antients, which, though I know not how many times bigger than the bullets of whole cannon, were not able to batter down walls and towers, like bullets, whose bulk, compared with theirs, is inconsiderable. Other examples of a like nature might be without impertinency alledged on this occasion ; but because the latter part of our proposition contains that, which I chiefly aim at, I shall proceed to instances fit to prove that.

I HAVE sometimes caused a skilful turner to turn for me an oblong piece of iron or steel, and placing my naked hand at a convenient distance to receive the little fragments, perhaps for the most part lesser than small pins heads, as they flew off from the rod, they were, as I expected, so intensely heated by the quick action of the tool upon them, that they seemed almost like so many sparks of fire ; so that I could not endure to continue my hand there. And I remember, that once asking an expert workman, whether he (as I had sometimes done) did not find a troublesome heat in the little fragments of brass, that were thrown off, when that metal was turning ? he told me, that heat was sometimes very offensive to his eyes and eye-lids. And when I asked, whether it was not rather as dust cast into them, than from their heat ? he replied, that, besides the stroke, he could sensibly feel a troublesome heat, which would make even his eye-lids sore : and that sometimes, when he employed a rough tool, that took off somewhat greater chips, he had found the heat so vehement, that not only it would scorch his tender eye-lids, but the thick and hard skin of his hands ; for proof whereof, he shewed me in one of his hands a little blister, that had been so raised, and was not yet quite gone off.

AND enquiring about these matters of a famous artist employed about the finishing up of cast ordnance, he confessed to me, that, when with a strong, as well as peculiar engine he and his associates turned great guns very swiftly, to bring the surface to a competent smoothness, the tools would sometimes throw off bits of metal of a considerable bigness, which, by reason of their bulk and their rapid motion, would be so heated, as to burn the fingers of the country-people, that came to gaze on his work, when he, for merriment sake, desired them to take up some of those pieces of metal from the

ground: which I thought the more remarkable, because, by the contact and coldness of the ground, I could not but suppose their heat to have been much allayed; not to mention, that I learnt from an experienced artificer, that in turning of brass the little fragments of that metal acquire an intenser heat, than those of iron.

I REMEMBER also, that to vary the experiment mentioned just before this last, by making it with a body far less solid and heavy, than brass or iron, I caused an artificer to turn very nimbly a piece of ordinary wood, and holding my hand not far off, the powder, that flew about upon the operation, struck my hand in many places with that briskness, that I could but uneasily endure the heat, which they produced where they hit; which heat, whether it were communicated from the little, but much heated, fragments to my hands, or produced there by the brisk percussive on my hand, or were the joint effect of both those causes, it will however be a good instance of the power of celerity even in very small bodies, and that move but a very little way.

It is considerable to our present purpose, that by an almost momentary percussive, and that made with no great force, the parts, even of a vegetable, may be not only intensely heated, but brought to an actual ignition; as we have several times tried, by striking a good cane (of that sort which is fit for such experiments) with a steel, or even with the back of a knife; for, upon this collision, it would send forth sparks of fire like a flint.

The cause
of a flint's
sparkling.
Mr. Hooke.

To the same purpose may be alledged, that, by but dextrously scraping good loaf-sugar with a knife, there will be made so brisk an agitation of the parts, that store of sparks will be produced. But that is more considerable, which happens upon the collision of a flint and a steel: for though vitrification be by chymists esteemed the ultimate action of the fire; and though, to turn sand or stones, though very finely powdered, into glass, it is usually required, that it be kept for divers hours in the intense fire of a glass-house; and though, lastly, the glass-men complain, that they cannot bring flints or sand to fusion without the help of a good proportion of Borillia or some other fixed salt; yet both actual ignition and vitrification are brought to pass almost in a moment by the bare vehemence of that motion, that is excited in the parts of a flint, when it is struck with a steel: for those sparks, that then fly out, (as an ingenious person has observed, and as I have often seen with a good microscope,) are usually real and permanent parcels (for the most part globulous) of stone vitrified and ignited by the vehemence of the motion. And that this vitrification may be of the stone itself, though steel be a metal of a far more fusible nature than a flint, I am induced to think, because I have tried, that not only flints with steel; but flints with flints, and more easily pieces of rock-crystal between themselves, will by collision strike fire. And the like effect of collision I have found myself in some precious stones, harder than crystal. And afterwards inquiring of an ingenious artificer that cuts diamonds, whether he had observed the like, when diamonds were grated on by the rapid motion of his mill? he replied, that he observed diamonds to strike fire almost like flints, which was afterwards confirmed to me by another experienced cutter of gems: and yet having made divers trials on diamonds with fire, he would not allow, that fire itself can bring them to fusion.

NOR are fluid bodies, though but of small dimensions, to be altogether excluded from the power of making considerable impressions on solid bodies, if their celerity be great.

WHETHER the sun-beams consist, according to the anatomical doctrine, of very minute corpuscles, that, continually issuing out of the body of the sun, swiftly thrust on one another in physically straight lines; or whether, as the Cartesians would have it, those beams be made by the brisk action of the luminary upon the contiguous fluid, and

and propagated every way in straight lines through some æthereal matter harboured in the pores of the air; it will be agreeable to either hypothesis, that the sun-beams, refracted or reflected by a burning-glass to a focus, do there, by their concurrence, compose a small portion of fluid matter; and yet the celerity, wherewith the soft and yielding substance is agitated, enables so few of them, as can be circumscribed by a circle not a quarter of an inch in diameter, to set afire green wood in less than a minute, and (perhaps in as little time as that) to melt not only tin and lead thinly beaten, but, as I have tried, foliated silver and gold.

THE operation of small portions of fluid matter on solid bodies will be farther exemplified in the fourth chapter, by the effects of the blown flame of a lamp on glass and metals; so that I shall here need but to point in general at the wonderful effects, that lightning has produced, as well by the celerity of its motion, as by the matter, whereof it consists: of which effects histories and the writings of meteorologists afford good store; and I have been an admiring observer of some of them, one of the last of which was, the melting of metal by the flame in its passage, which probably lasted but the twinkling of an eye.

AND even a small parcel of air, if put into a sufficiently brisk motion, may communicate a considerable motion to a solid body; whereof a notable instance (which depends chiefly upon the celerity of the springy corpuscles of the air) is afforded by the violent motion communicated to a bullet shot out of a good wind-gun. For when this instrument is well charged, the strongly-compressed air being set at liberty, and forcibly endeavouring to expand itself to its wonted laxity, its corpuscles give a multitude of impulses to the bullet, all the while that it continues moving along the barrel, and by this means put it into so rapid a motion, that I found, by trial, the bullet would, in a moment, be flattened almost into the figure of an hemisphere, by being shot off against a metalline plate. A wind-gun.

AND farther to shew, how swift that motion must have been, and with what celerity a vehement agitation may be communicated to the parts of a solid body, I shall add here, (though the phenomenon might be referred to the fifth chapter,) that, though the contact of the bullet and the metalline plate lasted probably but a physical moment; yet the minute parts of the bullet were put into so various and brisk an agitation, that making haste to take it up before it should cool, I found it too hot to be, with overmuch ease, held between my fingers.

C H A P. III.

O B S E R V A T I O N II.

We are too apt to think, that fluid bodies, because of their softness, cannot have by their bare motion, especially if insensible, any sensible effect upon solid ones; though the fluid moves and acts as an intire body.

IT is not my purpose here to insist on the efficacy of the motion of such fluid bodies, as may have their motions discovered by the eye like streaming water, or manifestly perceived by the touch, as are the winds, that beat upon us; since it were needless to give instances of such obvious things, as the great effects of overflowing waters and violent winds; the latter of which, notwithstanding the great tenuity and softness of the air, and the effluvia, that swim in it, have been sometimes able to blow down, not only timber-trees, but houses and steeples, and other the firmest structures. But the motions, I intend to speak of in this chapter, are such, as we do not immediately

ately either see or feel; and though these be exceeding rare, yet the operation of sounds, even upon solid bodies, and that at a distance from the sonorous ones, afford me some instances to my present purpose, which I shall now proceed to mention.

It has been frequently observed, that, upon the discharge of ordnance and other great guns, not only the sound may be distinctly heard a great way off; but that, to a good distance, the tremulous motion of the air, that produces sound, without producing any sensible wind, has been able sensibly to shake, and sometimes violently to break, the glass windows of houses, and other buildings, especially when the windows stand in the way, wherein the propagation of the sound is directly made. It is true, that these observations are most frequent, when the place, where the artillery is placed, stands upon the same piece of ground with the houses, whose windows are shaken; and so it may be suspected, that the shake is first communicated by the cannon to the earth or floor, on which they play, and is afterwards by that propagated through the intermediate parts of the ground to the foundations of the houses, and so to the windows. And I readily grant, and may elsewhere shew, that a violent impulse upon the ground may reach to a greater distance, than men usually imagine: but in our present case I see no necessity of having recourse to any thing but the wave-like motion of the air for the production of our phenomenon, since the like may be produced by local motion transmitted by fluids, as may appear by the following instances.

I WAS once invited by an engineer to see trial made of a strange instrument he had to sink ships, though great ones, in a few minutes; and though an unlucky accident kept me from arriving there, until near a quarter of an hour after the trial had been made on an old frigate with better success, than my philanthropy allowed me to wish; yet causing myself to be rowed to the place, where the great vessel was newly sunk, the oddness of the effect, which was performed upon the water by a small instrument outwardly applied, made me inquisitive, what noise and commotion had been made; and I was informed, partly by the engineer himself, and partly by some acquaintances of mine, who among a great number of spectators stood aloof off, in ships and other vessels lying at anchor, to see the event, that, upon the engineer's operating, the explosion was so great, that it made a kind of storm in the water round about, and did so rudely shake vessels, that lay at no inconsiderable distance, as to make those, that stood on them, to stagger.

In the late great sea-fight between the English fleet, commanded by his royal highness the duke of York, and the dutch admiral *Opdam*, (who therein lost the victory and his life,) though the engagement were made very many leagues from the *Hague*, yet the noise of the guns not only reached to that place, but had a notable effect there; of which when I enquired of the English ambassador, that as yet resided there, he was pleased to assure me, that it shook the windows of his house so violently, that not knowing what the cause was, he was surprized and much alarmed, apprehending, that some rude fellows were about to break his windows to affront him. - And if there be a greater disposition in some other bodies, than there is in glass-windows, to receive strong impulses from the air agitated by sounds, these may be sensibly, though not visibly, wrought upon, and that at a good distance, by the noise of a single piece of ordnance; as may appear by that memorable circumstance of an odd case about a gangrene mentioned by the experienced *Simon Pauli* in his ingenious tract *de Febribus malignis*, pag. 71. *Atqui æger ille Gallus brachio truncatus ostiduum quidem superfuit, sed horrendis totius corporis convulsionibus correptus; qui quoque, (ut & illa addam observatione dignissima,) dum in domini sui ædibus ad plateam Kiodmoggerianam, Romane Laniorum appellares,*

pellares, decumberet, ac, me ac aliis aliquandiu ad lectum illius confidentibus quidem, sed nobis non attendentibus, exploderentur tormenta bellica ex Regiis ac Prætoriiis navibus, sinistram truncum dextri brachii fovens ac complectens, toties quoties exploderentur singula exclamabat, Au, au, me miserum! Jesu, Maria, contundor penitus: adeo permolesta & intolerabilis illi erat tormentorum explosio, & quidem ex loco satis longinquo, terram non firmam aut contiguam, verum super solo aut mari Baltico instituta. “Simon Pauli, in his ingenious treatise of pestilential fevers, p. 71. tells us of a sick Frenchman, who lived several days after his arm was cut off, though he was all the while most cruelly tortured by not ordinary convulsion fits: but what is most observable is this, that I and others sitting one day by his bed-side, but not taking notice, that the great guns were going off from the king’s ships, he laying hold and cherishing the stump of his right arm, broke out at every shot into these pitiful words; *Jesu, Maria, What do I not suffer! I am quite bruised: so troublesome, and insufferable to him was the shooting of the great guns, though at a great distance, they being fired not in a joining continent, but on the Baltick-Sea.*” By this it appears, that the guns, whose discharge produced these painful motions in the patient, rested upon a floating body. And I remember, that an illustrious commander of a very great man of war being asked by me, whether of the many wounded men he had in his ship in a very long sea fight, none of them were affected by that noise of the enemy’s cannon discharged in ships at a distance? he answered me, that some, whose bones were broken, would sadly complain of the torment they were put into by the shake they felt at the going off of the enemy’s cannon, though they were too much accustomed to the report of great guns, to be, as it was a bare noise, offended by it. If after all this it be surmised, that these motions were not conveyed by the air, but propagated by the water, (and, in some cases, some part of the shore) from the ships, where the guns were fired, to the houses, where the windows were shaken, or the places, where the wounded men lay; I answer, that if this could be made probable, it would accommodate me with very eminent instances for the chapter of the propagable nature of motion: and though it be very difficult to find such examples of shakes excited by sounds, as are not liable to the mentioned objection, because the sonorous bodies here below do all either strike, or lean, upon such gross and visible bodies, as the earth and water; yet there is one kind of sound, that must be confessed to be propagated by the air, as being made in it; and that is thunder, whose noise does sometimes so vehemently affect the air, tho’ without producing any sensible wind, that both others and I have observed it very sensibly to shake great and strong houses, notwithstanding the distance of the clouds, where the noises were first produced. And I remember, that having enquired of some sea-captains, that in stout vessels sailed to the *Indies*, whether they had not in those hot regions observed their ships, though very much less tall than houses, to be shaken by vehement thunders? I perceived, that some of them had not much heeded any such thing; but a couple of others told me they had observed it in their ships; and one of them told me, that once, when the claps of thunder were extraordinary great, some of them shook his ship so rudely, as to make the unwonted motions disorder his great guns. All which I the less wonder at, when calling to mind, what I have mentioned in the foregoing chapter and elsewhere of the power of the celerity of motion, I consider, that there is no celerity, that we know of here below, that is near so great, as that, wherewith a sound is propagated through the air. For, whereas the diligent *Mersennus* observes, that a bullet shot out of a cannon or a musket does not overpass two hundred and forty yards in a second, or sixtieth part of a minute; I have more than once diligently observed, that the motion of sound passes above four hundred yards in the same time of a second here in *England*; which I therefore add, because

Mersennus

Mersennus relates, that in *France* he observed a sound to move in that time many yards more; which may possibly proceed from the differing consistence of the English air and the French.

THE great loudness of these sounds, and the vehement percussion, that the air receives in their formation, will probably make it be easily granted, that it was only the impetuosity of the motion of the *Medium*, that gave the shake to the windows and other solid bodies, that I have been mentioning to have been made to tremble by the report of cannon or thunder. But yet I will not on this occasion conceal, that perhaps it may without absurdity be suspected, that some of those tremulous motions of solid bodies might either depend upon, or at least be promoted by, some peculiar disposition, that glass (which is endued with springiness,) and some other bodies, that perhaps are not quite devoid of that quality, may have to be moved by certain congruous sounds (if I may so call them) more than they would by others, though perchance more loud: but though this surmise should be admitted, yet it would not render the lately recited instances improper for the design of this discourse, but only would make some of them fit to be referred to another chapter; to which I shall advance, as soon as I shall have annexed an odd observation of the experienced *Platerus*, which argues, that where there is a peculiar disposition, even in a firm body, it may receive considerable impressions from so languid a motion (though in likelihood not peculiarly modified) of the air, as is not sensible to other bodies of the same kind.

Fœmina quædam (says he) *in subitaneum incidit morbum, viribus subitò prostratis, se suffocari indefinenter clamitans, etsi nec stertoris nec tussis aliqua essent indicia; maxime verò de aura quadam adveniente, si vel leviter aliquis adstantium se moveret, quæ illam opprimeret, conquerebatur, seque suffocari, si quis propius accederet, clamitabat: vixit biduum in ea anxietate perseverans, expiravit.* To which he adds: *Vidi & alios ægros, de simili aura, quæ eos, si quis illis appropinquaret, in suffocationis periculum induceret, conquerebant; quod semper pessimum esse signum deprehendi.* “*Platerus* in the first book of his observations, p. 185. gives us this following account, p. 26. A woman being fallen sick on a sudden, complained continually of her being strangled, though there was no great appearance thereof; this she ascribed chiefly to a certain air or wind, which she was so sensible of, that if any body happened to come near her, she would immediately complain of her being choaked, and died the second day of this odd distemper. To which he adds, I have known several others complain of a not unlike wind, and that they were in danger of being choaked, if any body came near them; which I conceived always to be a very ill sign.”

C H A P. IV.

O B S E R V A T I O N III.

Men undervalue the motions of bodies too small to be visible or sensible, notwithstanding their numerousness, which enables them to act in swarms.

MOST men, when they think at all of the effluvia of bodies and their motions, are wont to think of them, as if they were but much finer sorts of dust, (whose grains, by reason of their smallness, are invisible,) which, by the various agitation of the air, are, as it were, by some faint wind blown against the surfaces of the bodies they chance to meet in their way, and that they are stopped in their progress without penetrating into the interior parts of the bodies they invade. And, according to this notion,

notion, it is no wonder, that men should not fancy, that such minute bodies passing, as they suppose, no further than the surfaces of those, on which they operate, should have faint operations upon them.

BUT we may have other thoughts, if we well consider, that the corpuscles we speak of, are, by their minuteness, assisted, and oftentimes by their figure enabled, to pierce into the innermost recesses of the body they invade, and distribute themselves to all, or at least to multitudes of the minute parts, whereof that body consists. For this being granted, though we suppose each single effluvium or particle to be very minute; yet, since we may suppose even solid bodies to be made up of particles, that are so too, and the number of invading particles to be not so much inferior to that of the invaded ones, or at least to be exceedingly great, it need not seem incredible, that a multitude of little corpuscles in motion (whose motion, may, for aught we know, be very swift) should be able to have a considerable operation upon particles either quiescent, or that have a motion too slow to be perceptible by sense: which may perhaps be the better conceived by the help of this gross example:

If you turn an ant-hill, well stocked with ants-eggs, upside down, you may sometimes see such a heap of eggs mingled with the loose earth, as a few of those insects, if they were yoked together, would not be able at once to draw after them; but if good numbers of them disperse themselves and range up and down, and each lay hold of her own egg, and hurry it away, it is somewhat surprising to see (as I have with pleasure done) how quickly the heap of eggs will be displaced, when almost every little egg has one of those little insects to deal with it.

AND in those cases, wherein the invading fluid does not quite disjoin and carry off any great number of the parts of the body it invades, its operation may be illustrated by that of the wind upon a tree in autumn: for it finds or makes itself multitudes of passages, for the most part crooked, not only between the branches and twigs, but the leaves and fruits; and in its passing from the one side to the other of the tree, it does not only variously bend the more flexible boughs and twigs, and perhaps make them grate upon one another, but it breaks off some of the stalks of the fruit, and makes them fall to the ground, and withal carries off divers of the leaves, that grew the least firmly on, and in its passage does, by its differing parts, act upon a multitude of leaves all at once, and variously alters their situation.

BUT to come to closer instances: suppose we cast two lumps, the one of sugar, the other of amber, into a glass of beer or water, they will both fall presently to the bottom. And though perhaps the amber may be lighter than the sugar, (for, I have found a notable difference in the specific gravity of pieces of amber,) yet the aqueous particles are far from being able to displace the amber or any sensible part of it, or exercise any visible operation upon it: but the same minute particles of the liquor being of a figure, that fits them to insinuate themselves every way into the pores of the sugar, though the lump consisted of very numerous saccharine corpuscles, yet the multitude of the aqueous particles, to which they are accessible, is able in no long time to disperse them all, and, carrying them along with themselves, make the whole lump of sugar in a short time quite disappear.

THE point above discoursed of may be more nimbly exemplified in some chymical operations, and particularly in this. If, by a due degree of fire, you abstract from running mercury four or five times its weight of good oil of vitriol, there will remain at the bottom a dry and brittle substance exceeding white; and if upon this heap of mercurial and saline bodies, which sometimes may be coherent enough, you pour a good quantity of limpid water, and shake them together, you may see in a trice the multitude of little white grains, that make up the mass, pervaded and manifestly altered

tered by the dispersed corpuscles of the water; as will plainly appear by the change of the calx or precipitate from a white mass into one of a fine lemon colour.

BUT, to give instances in fluid bodies, (which I suppose you will think far the more difficult part of my task,) though you will easily grant, that the flame of spirit of wine, that will burn all away, is but a visible aggregate of such effluvia swiftly agitated, as without any sensible heat would of themselves invisibly exhale away; yet, if you be pleased to hold the blade of a knife, or a thin plate of copper, but for a very few minutes, in the flame of pure spirit of wine, you will quickly be able to discern by the great heat, that is, the various and vehement agitation of the minute corpuscles of the metal, what a number of them must have been fiercely agitated by the pervasion of the igneous particles, if we suppose, (what is highly probable,) that they did materially penetrate into the innermost parts of the metal; and whether we suppose this or no, it will, by our experiment, appear, that so fluid and yielding a body, as the flame of spirit of wine, is able, almost in a trice, to act very powerfully upon the hardest metals.

THE power of extremely minute parts of a fluid body, even when but in a moderate number they are determined to conspire to the same operation, may be estimated by the motions of animals, especially of the larger and more bulky sorts, as horses, bulls, rhinoceroses and elephants. For though the animal spirits be minute enough to be invisible, and to flow through such tender passages, that prying anatomists have not been able in dissected nerves to discern so much as the channels, through which they pass; yet those invisible spirits, conveyed (or impelled) from the brain to the nerves, serve to move in various manners the limbs, and even the unweildy bodies themselves of the greatest animals, and to carry them on in a progressive motion for many hours together, and perhaps enable them to spring into the air, and move through it by leaping; though divers of these animals weigh many hundred, and others several thousand of pounds.

I WILL not here consider, whether the following experiment may at all illustrate motions, that are produced by the fluid parts of animals in some of the consistent ones: but I presume it may confirm the observation maintained in this chapter, if I add, what I have tried of the considerable force of a number of aqueous particles, as flexible and as languid as they are thought to be, insinuating themselves into the pores or intervals of a rope, that was not thick. For in moist weather I sometimes observed, that the aqueous and other humid particles swimming in the air, entering the pores of the hemp in great numbers, were able to make it shrink, though a weight of fifty, sixty, or even more pounds of lead were tied at the end to hinder its contraction, as appeared by the weight's visibly being raised in wet weather above the place it rested at in dry.

BUT to return to what I was formerly speaking of the determination of the motion of fluids; I shall on this occasion observe, that though the wind or breath, that is blown out at a small crooked pipe of metal or glass, such as tradesmen for its use call a blow-pipe, seems not to have any great celerity, especially in comparison of that of the parts of flame, and is itself of little force; yet, when by this wind the flame of a lamp or candle is directed so, as to beat with its point upon a body held at a convenient distance from the side of the flame, the burning fluid, determined, and perhaps excited by this wind, acquires so great a force, that, as we have often tried, it may be made in a few minutes to melt not only the more fusible metals, but silver, or even copper itself; which yet may be kept for many hours unmelted in a crucible kept red-hot, or even in the flame of the lamp or candle unassisted by the blast.

AND

AND if we can so contrive it, that a flame does not come to invade only the surface, that invests a body, but comes to be intermingled with the smaller (though not the smallest) parts it consists of, as with its filings or its powder; the flame will then have a far more quick and powerful operation than the body exposed to it. This I exemplify (in other papers,) and in this place it may suffice to observe, that, whereas a pound or two of tartar may cost you some hours to calcine it to whiteness, if the flame have immediate access only to the outward parts; you may calcine it in a very small part of that time, if, mixing with its gross powder an equal weight of good salt-petre, you fire the mixture, and keep it stirring, that the parts of the kindled nitre may have access at once to very many parts of the tartar, and have opportunity to calcine them. And by somewhat a like artifice I elsewhere teach, how nitre itself may without tartar be speedily reduced to a calcinatum not unlike that newly mentioned. But it may be said, that some of the foregoing instances (for it cannot be truly said of all) may indeed illustrate what we are discoursing of, but will not reach home to our purpose.

I SHALL therefore consider the load-stone, which you acknowledge to act by the emission of insensible particles. For though iron and steel be solid and ponderous bodies, and magnetical effluvia be corpuscles so very minute, that they readily get in at the pores of all kinds of bodies, and even of glass itself; yet these magnetical effluvia entering the steel in swarms, do in a trice pervade it, and a multitude even of them acting upon the corpuscles of the metal do operate so violently on them, that if the load-stone be vigorous enough, and well capped, it will attract a notable proportion of steel, and surmount the gravity of that solid metal, which I have found to exceed, when the stone has been very good and little, above fifty times the weight of the magnet, by whose effluvia it was supported: for to these I rather ascribe magnetical attraction and sustentation, than to the impulse or pressure of the ambient air, to which many corpuscularians have recourse; because I have found by trial (which I elsewhere relate) that the pressure of the ambient air is not absolutely necessary to magnetical operations.

I REMEMBER, that to help some friends to conceive, how such extremely-minute particles, as magnetical effluvia, may, by pervading a hard and solid body, such as iron, put its insensible corpuscles into motion, and thereby range them in a new manner, I took filings of steel or iron freshly made, that the magnetical virtue might not be diminished by any rust; and having laid them in a little heap upon a piece of paper held level, I applied to the lower side of the paper, just beneath the heap, the pole of a vigorous load stone, whose emissions traversing the paper, and diffusing themselves through the incumbent metal, did in a trice manifestly alter the appearance of the heap; and though each of the filings might probably contain a multitude of such martial corpuscles, as steel may be divided into by oil of vitriol or spirit of salt, yet the magnetical effluvia immediately pervading our metalline heap did so remove a good part of the filings, that composed it, as to produce many erected aggregates, each of which consisted of several filings placed one above another, and appearing like little needles, or rather like the ends of needles broken off at some distance from the point: and as these little temporary needles stood all of them erected (though more or less, according to their distance from the pole of the magnet) upon the flat paper; so they would, without losing their figure or connexion, be made, as it were, to run to and fro upon the paper, according as the load-stone, that was held underneath it, was moved this way and that way; and as soon as that was taken quite away, all this little stand of pikes (if I may so call it) would (almost in the twinkling of an eye) relapse into a confused heap of filings.

Opinions of freezing THERE are two ways of explicating the turning of water into ice; one or other of which is approved almost by all the corpuscularian philosophers. The first is that of the Cartesians, who give an account of glaciation by the recess of the less subtle particles of the ethereal matter, without which the finer parts were too small and feeble to keep the eel-like particles of water flexible, and in the form of a liquor. The atomists on the other side ascribe the freezing of water to the ingress of multitudes of frigorific corpuscles, as they call them, which, entering the water in swarms, and dispersing themselves through it, crowd into the pores, and hinder the wonted motion of its parts, wedging themselves (if I may so speak) together with them into a compact body. But which soever of these two hypotheses be pitched upon, the phenomenon itself will afford me a notable instance to my present purpose. For the particles of water, and much more the corpuscles of cold, are confessed to be singly too small to be visible, and their motions are not said to be swift, but may rather be judged to be slow enough; and yet those minute aqueous, or more minute frigorific particles, because of their number, produce in the glaciation of the liquor so forcible a motion outwards, as to make it break bottles, not only of glass and earth strongly baked, but, as I have several times tried, of metal itself, that, being full of the liquor, were firmly stopped before the supervening of the cold. And the expansive endeavour of freezing water is not only capable of doing this, but of performing so much greater things, which I elsewhere relate, that my trials have made me sometimes doubt, whether we know any thing in nature, except kindled gunpowder, that bulk for bulk moves more forcibly, though the motion seems to be very slow.

C H A P. V.

(Of the propagable nature of motion.)

O B S E R V A T I O N IV.

Men are not sufficiently aware, how propagable local motion is, even through differing mediums and solid bodies.

THERE are four principal occasions, on which I have observed, that men are wont to think the communicating of motion much more difficult, than indeed it is.

AND first, there are many, that observing how usually those bodies, that hit against hard ones, rebound from them, easily persuade themselves, that motion can scarce be transmitted or diffused through solid bodies. But, though it be true, that oftentimes in such cases the progressive motion of the body or the solid, that is struck or impelled, be either inconsiderable, or perhaps not so much as sensible; yet the impulse may make a considerable impression, and may be communicated to a great share of the particles of that matter, whereof the solid mass consists; as we see in the striking of a timber-beam at one end, the motion, though perhaps it were not strong at the first, may become sensible at the other. Though bell-metal be so hard a body, that it is reckoned harder than iron itself, insomuch that oftentimes it resists even files of steel, which readily work on iron; yet this solidity hinders not, but that, as I have found, conveniently shaped vessels of bell-metal, though thick, will be sensibly affected by a motion, that neither is strong, nor touches them in more than a short line, or perhaps than a physical point. The truth of this I have found by trial on more than one such vessels, and particularly on one, that was hemispherical, which being placed or held in

a convenient posture, if I did but gently pass the point of a pin for a little way along the brim of it, it would sensibly resound, and that (to a very attentive ear) so long, and in such a ringing manner, as made it highly probable, that the parts immediately touched (and not so much as scratched) by the point of a pin, were not only put into a vibrating motion themselves, but were enabled to communicate it to those, that were next them, and they to those, that were contiguous to them; and so the tremulous motion was propagated quite round the bell, and made divers successive circulations before it quite ceased to be audible. And if instead of drawing a line on the brim of the vessel, I struck it, though but faintly, with the point of a pin, though the part immediately touched would be but a physical point, yet the motion would be, like the former, propagated several times quite round; as was argued by the ringing and duration of the produced sound, though this metalline vessel were seven inches in diameter, and of a considerable thickness. Nor was a solidity like that of brass requisite to produce these effects; for I found them to insue much after the same manner, when I employed only a short and slender thread of glass, which, though little, if at all, thicker than a pin, was yet hollow quite through. Now, if it be true, as it is highly probable, that sound, as it belongs to the air, consists in an undulating motion of the air, and so in our case requires a vibrating motion in the sonorous body to impart that motion to the air: we must grant in our instances a wonderful propagableness of motion, even when it is not violent, in solid bodies themselves; since the point of a pin, gently striking a part, no bigger than itself, of a mass of very solid metal, could thereby communicate a sensible motion, and that several times circulated, to millions of parts equal to it in bulk, and much exceeding it in hardness. And since the effect was more considerable, when the trial was made in a much greater, than in a smaller vessel; it is probable, that, if I had had the opportunity of experimenting on a large and well hung bell, the phenomenon would have been more notable; as it also seemed to be on our vessel, if, instead of striking it with the point of a pin, we cast, though but faintly, against the lower part of it a grain of shot, less than a small pin's head, or let a little grain fall from about one foot high, upon the inside of the inverted hemisphere. And to shew, that even soft and yielding bodies, and but faintly moved, are not to be excluded from a power of putting such hard ones into motion; I shall add, that I found almost the like effects to those above-mentioned, by passing the pulp of my finger a little way along the lower part of the vessel. Nay, that fluid bodies themselves may communicate such an intestine and propagable motion to hard and solid ones, I may have hereafter an occasion to shew by the effects of a small flame and the sun beams on glass and steel. And I shall here on this occasion add this word about the propagation of motion produced in solid bodies by heat, that it much depends upon the particular textures of the bodies; for I found, that when I heated a piece of glass or of a fire-stone, I could without inconvenience hold my naked hand upon parts, that were very near (suppose within an inch off) the ignited portions of them: but, if we take a rod of iron, for instance, and heat one end red-hot, the heat of that end will be so propagated towards the other, that it will offend one's hand at several times the distance, at which one might conveniently hold the rod, if it were of glass.

In many buildings it may be observed, (and is thought a sign of the firm cohesion of their parts), that a stamp of one's foot, nay, or bear treading, or some such other less brisk impulse, made in one room, will have a sensible effect in all or most of the others. And it often happens, that by the hasty shutting of a door, the whole house is made to tremble; whence we may argue, that, even among solid bodies, motion made in one place may be readily propagated to many others: and if, as to the latter of the instances, the sudden impulse and compression of the air, made by the door

supposed.

supposed to be hastily shut, have any considerable share in the effect, the phænomenon will serve to shew the efficacy even of such a motion of a fluid body, as we cannot directly feel upon divers large and firmly connected solid bodies.

A (highly
probable)
cause of
earth-
quakes.

Natur.
Quæst.
Lib. IV.
Cap. 25.
Lib. III.
Cap. 26.

In earthquakes the tremulous motion sometimes extends so very far, that though it seems highly probable, that the shake, that is given to one part of the earth by the firing and explosion of subterranean exhalations, (if that be the true and only cause of earthquakes) is not capable of reaching near so far as divers earthquakes have done, but that the fire passes through some little subterranean clefts, or channels, or hidden conveyances, from one great cavity or mine to another; yet it is not improbable, but that the vehemently tremulous motion does oftentimes reach a very great way beyond the places, where the explosions were made; since, though *Seneca* would confine the extent of earthquakes to two hundred miles, yet observations made in this and the last century warrant us to allow them a far greater spread. The learned *Josephus Acofta* affirms, that in the kingdom of *Peru*, in the year 1586, an earthquake reached along the shore of the pacific sea 160 leagues; and adds, that sometimes it has in those parts run on from south to north 300 leagues. And in the beginning of this our age (*anno dom. 1601*) good writers relate a much larger earthquake to have happened, since it reached from *Asia* to that sea, that washes the *French* shores, and, besides some *Asiatic* regions, shook *Hungary*, *Germany*, *Italy*, and *France*, and consequently a great part of *Europe*. And if that part of the narrative be certain, which relates, that this lasted not much above a quarter of an hour, it will be the more likely, that this earthquake shook great tracts of land beyond those places, to which the fired matter, passing from one cavity to another, could reach in so short a time: as you will the more easily guess, if you try, as I have done, that in trains of gunpowder itself the fire does not run on near so swiftly as one would imagine. But though I have been in more earthquakes than one; yet, since they were too sudden and too short to afford me any considerable observation, I shall say no more of them; but proceed to take notice, that oftentimes the motion of a coach or cart, that passed at a good distance from the place I was in, has made the buildings so sensibly shake, that I could not but wonder, that so great a portion of so firm and sluggish a body, as the earth, could, by a cause, that seemed very disproportionate to such an effect, be made to tremble itself, and manifestly to shake firm buildings, that were founded on it. And this observation made me the more inclinable to give credit to their relations, who tell us, that in a calm night, the march of a troop of horse may be felt by attentive scouts watching at a great distance off, by the shake, that the ground receives from the trampling of the horses; though I formerly suspected much, and do yet a little, that the impulse of the air conveyed along the resisting surface of the ground might mainly contribute to the effect, that is ascribed only to the motion of the soil.

BEFORE I advance to the second member of this chapter, it may not be impertinent to note, that in peculiarly disposed bodies, and especially in organical ones, a very languid motion may have a far greater effect, than it could produce by a bare propagation of itself. For it may so determine the motion of the spirits or other active parts of the body it works on, as to make multitudes of them act as if they conspired to perform the same motions. As when a ticklish man, by having the pulp of one's finger passed gently along the sole of his foot or the palm of his hand, has divers muscles and other parts of his body and face put into preternatural or unusual motions. And most men, by being lightly tickled with the end of a feather or straw within their nostrils, have their heads and many parts of their bodies put into that violent commotion, wherein sneezing consists. And I remember, that having for some time been, by a distemper, (from which God was graciously pleased a while after

after to free me,) quite deprived of the use of my hands; it more than once happened to me, that sitting alone in a coach, if the wind chanced to blow a single hair upon my face in the summer time, the tickling or itching, that it produced, was so uneasy to me, until by calling out to a footman I could get it removed, that, though I could well bear it as long as I was wont to do, when, having the use of my hands, I could relieve myself at pleasure; yet if I were forced to endure the itching too long, before any came to succour me, the uneasiness was so great, as to make me apprehend falling presently either into convulsions or a swoon. But it is time to proceed to the second member of this chapter.

2. OTHERS there are, that cannot believe, that local motion, especially if it be languid, can be propagated through differing mediums, each of which, save that wherein the motion is begun, must, they think, either repel, or check and dead it. To these I shall recommend the consideration of an experiment, I remember I made before some learned men in our pneumatick engine: for having caused a large thick glass receiver to be so blown, that it had a glass button in the inside of that part, which upon the engine was to be placed upwards, I caused a watch to be suspended by a little silver chain fastened to that button by as slender and soft a body, as I thought would be strong enough to support my watch; and then, the glass being cemented on close to the receiver, to prevent a commerce between the cavity of it and the air, the watch, that hung freely near the middle of the cavity of the receiver, made itself to be heard by those attentive listners, that would hold their ears directly over the suspended watch, whose motions were thereby argued to have been propagated either through the included air, or along the string, to the concave part of the glass, and through the whole thickness of the glass to the convex part, and thence through the interposed air to the ear. And this mention of watches minds me of what I often observed in a small striking watch, that I have worn in my pocket; for when it struck the hours, and in some postures, when the balance did but move, I could plainly feel the brisker motions of the bell, and sensibly the languid ones of the balance, through the several linings of my breeches, and some other interposing soft and yielding bodies; and this, though the watch (as I said) was small, and the balance included in a double case, and though the outwardmost were of (what they call) shagreen, and the innermost of gold; which I therefore mention, because that closest of metals is observed more to dead sounds and motions, than harder metals, as silver, copper and iron.

THAT motion may be propagated through differing mediums, may seem the more probable by the shakings, that are often felt by men lying on beds, that stand in rooms close shut, when loud claps of thunder are produced (perhaps at a great distance off) in the clouds. And whether it will be fit to add to this instance that, which you have lately met with in the third chapter, of a wounded Frenchman at Copenhagen, I leave you to consider."

I KNOW not, whether it will be very proper to take notice, on this occasion, of an odd phenomenon recited by the experienced *Agricola*, in these words: *Si animal dejicitur in autrum Viburgense, quod est in Carelia, regione Scandiae, erumpit, ut perhibent, sonus intolerabilis magno cum flatu: si leve pondus in specum Dalmatiae, quamvis, inquit Plinius, tranquillo die, turbini similis emicat procella.* "If you throw down an animal into the hole of *Viburg*, which is in *Carelia*, a country in *Scandia*, it is reported, that there breaketh immediately forth a great and insufferable sound, together with a strong wind: if a small weight be thrown into the gap of *Dalmatia*, though, says *Plinius*, in a calm day, there is a storm immediately raised, not unlike that, which is occasioned by a whirlwind."

3. As those, of whom I took notice at the beginning of this chapter, are backward to allow, that motion may be considerably propagated through solid bodies; so on the contrary, there are others, that are indisposed to think, that it is near so propagable, as indeed it is through fluid bodies; because they presume, that the easy cession of the parts of fluids will dead the impulse received by those of them, that are first acted on by the impelling body. And

4. THERE is yet another sort of naturalists, who, though they may be brought to grant, that motion may be propagated even through a soft and yielding medium, cannot believe, that it should through such a medium be propagated to any considerable distance; being perhaps induced to this opinion by observing, that though a body somewhat broad as well as solid, as the palm of one's hand, or a battledore, be moved through the air swiftly enough to make a wind; yet that wind will not be strong enough to be felt any more than a very little way off. Wherefore, because the instances, to which I assign the remaining part of this chapter, may be for the most part applicable to the removal of both these prejudices; it may, for brevity sake, be expedient to consider them both together.

*Des Cartes
judgment
of light.*

*A proba-
bility, that
the fixed
stars are
so many
uns.*

IF luminous bodies act on our eyes, not by a substantial diffusion of extremely minute particles, as the atomists would have it, but by a propagated pulsion of some subtile matter contiguous to the shining body, (as the Cartesians, and many other philosophers maintain) it will be manifest, that a body less than a small pin's head may give a brisk motion to a proportion of fluid matter, many millions of times greater than itself; since in a dark night a single spark of fire may be seen in different places, whose distance from it exceeds many thousand times the spark's diameter: not to mention the great remove, at which the flame of a small taper may not only be seen, but appear greater than near at hand. And if we compare the diameter of that bright planet Venus, which yet shines but with a borrowed and reflected light, with its distance from the earth, we may easily conclude, that the fixed stars, which probably are so many suns, that shine by their own native light, must impel a stupendous proportion of ætherial matter, to be able at that immense distance to make such vivid impressions, as they do, upon our eyes. But to descend to instances less remote and disputable, I shall, in order to the removal of the two lately mentioned prejudices, proceed to consider; that, though it be true, that fluid bodies do easily yield to solid ones, that impel them, and thereby oftentimes quickly dead the motion of those solids; yet the motion being lost only in regard of the solid body, is not lost, but transmitted and diffused in reference to the fluid: as when a log of wood, or any such body specifically lighter than water, is let fall in the middle of a pond, though its progress downwards be checked, and it be brought to rest quietly on the surface of the water, yet its motion is not lost, but communicated to the parts of the water it first strikes against, and by those to others, till at length the curls or waves produced on the surface of the water spread themselves, till they arrive at the brinks, and would perhaps be farther expanded, if these did not hinder their progress. From which instance we may learn, that, though the nature of fluid bodies, as such, requires, that their parts be actually distinct and separately moved, yet the particular corpuscles, that compose them, being (at least here below) touched by divers others, the new motion, that is produced in some of them by an impellent solid, must needs make them impel the contiguous corpuscles, and these those that chance to lye next to them; and so the impulse may be propagated to a distance which you will the more easily believe may be great, if you consider with me, both that in a fluid body the corpuscles, being already in the various motion requisite to fluidity, yield more easily to the impellent, and also that being fully, or very near it, counterpoised by others of the

the same fluid, a scarce imaginably little force may suffice to impel them; insomuch that, though the brass scale of a balance, of divers inches in diameter, may well be supposed to outweigh many myriads of such particles as compose water, wine, &c. yet, (as I elsewhere more fully relate) when such a scale was duly counterpoised with another like it, I could easily put it into various motions only with the invisible effluvia of no great piece of amber. And if we consider that obvious instance of the swelling circles made by casting a stone into a pond, or other stagnant water, we shall be the more easily persuaded, that, even in a heavy fluid, a motion may reach a far greater way, than men are usually aware of, beyond the parts on which it was first impressed.

On this occasion I must not omit a strange observation given me by a very experienced navigator, that much frequents the coast of *Groenland*, and other arctic regions, to fish for whales: for this person being discoursed with by me about the effects of the breaking of those vast piles of ice, that are to be met with in those parts, assured me, that not only he had often heard the ice make, in breaking, a terribler noise than the loudest claps of thunder with us; but that sometimes, when the seawater had, as it were, undermined the foundation of the mountainous piece of ice, he has known it at length suddenly fall into the subjacent sea, with so much violence as to make a storm at a great distance off; insomuch that once, when he lay two leagues off the place, where this stupendous mass of ice fell, it made the waves go so high, as to wash clear over the stern of the ship, with danger enough to some of his men, and to sink several of his shallops, that were riding by, though scarce any small vessels in the world use to be so fitted for rough seas, as those about *Groenland*.

AND whereas, though the air be a much thinner fluid, we are apt to think it indisposed to propagate motion far, give me leave to tell you, that we take wrong measures, if we think, that (for instance) the undulating motion, into which the air is put by the action of sonorous bodies, reaches but a little way, as we are apt to presume it does, because we judge of it by the effect it has on our ears, when the sound is made in disadvantageous places. For one, that, for instance, hears a lute or a viol played on in a room furnished with hangings, will be apt to think the sound faint and languid, in comparison of what it would appear to him, if the same instrument were played on after the same manner in an arched room without hangings; these soft and yielding bodies being apt to dead the sound, which the figure and hardness of the vaulted room would reflect. And so, when a man speaks aloud in the free air, we are not wont to take any notice of a progress made by the motion of the air beyond the place we are in, when our ears receive the sound; but if the place happen to be furnished with echo, though at many times that distance from the speaker, we may then easily take notice, that the motion of the air was carried on, and that with good vigour, to a far greater distance, than else we should have observed. And I have often thought, that, even by the better sort of our echoing places, we are not informed to near how great a sphere the motion, which the air is put into by sounds, may extend itself, where its diffusion and vigour are not hindered nor weakened by bodies, either placed too near, or indisposed to promote its operation.

WHAT has been lately said of the great diffusion of sounds, if themselves be loud and great, will appear highly probable, by what is related by the learned *Fromundus*, who being professor of philosophy at *Louvain*, in the year 1627, had opportunity enough to know the truth of what he relates; namely, that at the famous siege of *Ostend* in *Flanders*, the thunder of the great ordnance was heard at above thirty Dutch leagues, which, according to the vulgar reckoning, amounts to a hundred and twenty of our English miles; and that is yet, as he truly observes, more strange, and makes

From. Meteor. lib. 2. art. 9.

more for our present purpose, which he adds concerning the diffusion of the sound of a drum, which, he says, was, upon a time, heard at sea twelve leagues off.

Geograph.
general.
lib. 1. c. 19.

BUT to return to what I was saying of echos, to confirm my conjecture about them, I shall think it needless to offer you any other argument, than that, which you will draw yourself from the notable relation I met with in the learned *Varenius*, of an observation made by *David Frælichius*, who, in the company of a couple of students, had the curiosity (in the month of June) to visit the mountain *Carpathus*, esteemed the highest of all the Hungarian hills, and said to be much more steep and difficultly accessible, than any of the Alps themselves. *Frælichius* then (in my author) having related with what difficulty he and his companions ascended above that region of the air, where they met with clouds and vehement winds, adds this memorable observation, for whose sake I mention the story: *Explosi* (says he) *in ea summitate sclopetum, quod non majorem sonitum primò præ se tulit, quam si tigillum vel bacillum confregissem; post interval- lum autem temporis murmur prolixum invaluit, inferioresque montis partes, convalles, et sylvas opplevit. Descendendo per nives annosas intra convalles, cum iterum sclopetum exonerarem, major & horribilior fragor quàm ex tormento capacissimo inde exoriebatur: hinc verebar, nè totus mons concussus mecum corrueret; duravitque hic sonus per semiquadrantem horæ, usque dum abstrusissimas cavernas penetrasset, ad quas aer undique multiplicatus resiliit. Et talia quidem objecta concava in summitate se non illico offerebant, idcirco ferè insensibiliter primùm sonus repercutiebatur, donec descendendo antris et convallibus vicinior factus ad eas fortius impegit.* “I discharged a pistol, being upon the top of the hill, which at first made
“no greater noise than that, which usually happens at the breaking of a small rod;
“but after a little while the noise became stronger, and filled the lower parts of the
“hill, the vallies, and neighbouring woods. Now coming down lower through
“snow, that had lain there several years, and having discharged again the pistol, the
“noise became, on a sudden, louder, than that of the greatest guns: which gave me
“some grounds to fear, that the whole hill, being thus shaken, should at length
“subside: this sound lasted half a quarter of an hour, till it had penetrated into the
“remotest grotto’s, whence the parts of the air thrusting one another had been
“strongly reverberated; and because no such concavities were in the top of the hill,
“the sound was first insensibly reverberated, till coming lower and nearer the grotto’s
“and vallies, it was strongly dashed against them.”

C H A P. VI.

O B S E R V A T I O N V.

Men usually think not, what the modification of the invisible motion of fluids may perform on the disposed bodies of animals.

IN this observation I expressly mention the disposed bodies of animals, to intimate, that there is a peculiar aptitude required in those animals, or some particular parts of them, that are to be sensibly affected by such motions, as we are treating of, which would otherwise be too languid to have any sensible operation on them.

It seems the less strange to me, that continuing sounds, and other somewhat durable impulses of the air or other fluids, should have a manifest operation upon solid bodies, when I consider the multitude of strokes, that may in a very short, and perhaps scarce observable time, be supposed to be given by the parts of the fluid to the consistent body; for though each of these single would perhaps be too languid to have any sensible effect at all; it being opportunely and frequently repeated by the successive parts

of

of the fluid, as by so many little swimming hammers or flying bullets, they may well have a notable effect upon the parts of a body exposed to their action : as may be argued from the great swing, that may be given to pendulums, by a very languid force, if it successively strike the swinging body, when having finished its excursion, it is ready to return towards the perpendicular ; as also from the tremulous motion, that is imparted even to the metalline string of a musical instrument, by the congruous motion the air is put into by another trembling string, (as there may be hereafter occasion to declare.)

I REMEMBER *Scaliger* tells a pleasant story of a knight of *Gascony*, whom the sound of a bagpipe would force presently to make water ; adding, that a person disoblinded by this man, and resolving to be merrily revenged on him, watched a time when he fate at a feast, so as he could not well get out, and brought a bagpiper to play unawares behind him ; which he did so unluckily, that the musick had presently its wonted effect upon the poor knight, to his great confusion, and the laughter of the company. On which occasion I shall add, that I know a very ingenious gentleman, who has confessed to me, that the noise of a running tap is wont to have almost the like operation upon him.

It is a common observation, that the noise, that an ungreaed cart-wheel makes in grating against the axletree, and the scraping of a knife upon a plate of silver or pewter, and some other brisk and acute sounds, do so affect divers parts of the head, as to produce that effect, that is commonly called setting the teeth on edge ; which, whether it proceed from any commerce between the auditory nerves, and those that are inservient to the motion we have mentioned, I leave anatomists to consider. But these effects of acute sounds are much less considerable than that, which I elsewhere relate of an ingenious domestick of mine, who several times complained, that the tearing of brown paper made his gums bleed ; which argued, that the sound had an operation not only upon the nervous and membranous parts, but the blood and humours themselves.

SIR HENRY BLOUNT, in his voyage to the *Levant*, giving an account of what he observed in *Egypt*, has, among other remarkable things, this passage : many rarities of living creatures I saw in *Grand Cairo*, but the most ingenious was a nest of four-legged serpents, of two feet long, black and ugly, kept by a Frenchman, who, when he came to handle them, they would not endure him, but ran and hid in their hole ; then would he take his cittern and play upon it ; they hearing his musick, came all crawling to his feet, and began to climb up him, till he gave over playing ; then away they ran.

THIS recalls to my mind, what some men of repute, and particularly the learned *Kircherus*, relate concerning a great fish, in or about the streights, that sever *Sicily* from *Italy*, which is said to be much affected with a peculiar kind of tune (harsh enough to human ears) by which the mariners are wont to allure it to follow their vessels. And it may much strengthen the conclusion maintained in this chapter, if there be any certainty in the famous tradition, that the lion is terrified, and made to run away by the crowing of a cock : I say *if*, because though I doubt not but some peculiar kinds of sounds, as well as of other sensible objects, may be particularly and exceedingly ungrateful to the sensories of this or that peculiar kind of animals, and consequently to the ears of lions ; yet a late French traveller into the *Levant* gives me cause much to question the matter of fact, affirming, that rowing along the brink of *Tigris* or *Euphrates*, (for I do not punctually remember which) they were, for many hours in the night, terrified by lions, that attended them along the brink of the river, and would not at all be frightened by the frequent crowing of the cocks, that chanced to

Lions
frighted
by the
crowing
of cocks,
a vulgar
error.

be in the passengers boat: of which unconcernedness of the lions our observing traveller took much more notice, than the lions appeared to do of the crowing of the cocks. I might, on this occasion, say something of the received tradition, that many sleeping persons will be more easily waked by being called upon by their own usual names, than by other names, though uttered with a louder voice: but this it may suffice to have mentioned; nor will I here insist on that more certain example of the operation of a sound, which is afforded by the starting of men or greater animals, upon a surprising, though not vehement noise; though this oftentimes puts so many of the spirits and muscles into motion, that the whole bulk of the animal is suddenly raised from the ground, which perhaps it could not be by the bare counterpoise of some hundreds of pounds: this I say, I will not in this place insist on, because the phænomenon seems to depend rather upon the loudness or acuteness of the sound, than upon any determinate modification of it, particularly relating to the animal itself.

See *San-*
dy's
travels.

BUT the eminentest instance of the efficacy of peculiarly modified sounds upon disposed bodies, is afforded by what happens to those, which are bit by a tarantula: for though the bitten person will calmly hear divers other tunes, yet when a peculiarly congruous one comes to be played, it will set him a dancing with so much vigour, as the spectators cannot but wonder at, and the dancing will sometimes continue many hours, if the musick do so, and not otherwise. I know there are some, that question the truth of the things related of these Tarantati, (as the Italians call them) and I easily grant, that some fictions may have been suffered to pass under the countenance of so strange a truth: but besides the affirmations of some learned men, (as well physicians as others) my doubts have been much removed by the accounts I have received from an ingenious acquaintance of mine own, who at *Tarentum* itself, whence the insect takes its name, and elsewhere, saw many bitten persons in their dances, some in publick and some in private places, and amongst the rest a physician, on whom the tune, that fitted his distemper, had the same operation as on the other patients. And the learned *Epiphanius Ferdinandus*, who practised physick in *Apulia* and *Calabria* for many years, not only delivers, upon his own personal observation, several narratives of the effects of musick upon the Tarantati, but invites any, that may doubt of the truth of such narratives, to repair to him at a fit season, undertaking to convince them by ocular demonstration.

I know a very honest and sober musician, who has divers times affirmed to me, that he could at pleasure, by playing a certain tune, (which he acquainted me with, and which did not move others) make a person (whom he named to me) weep, whether she would or no. And I might add, that when I have been taking physick, or am any thing feverish, the repetition of two verses of *Lucan* seldom fails (as I have often tried) of producing in me a chillness, almost like that, but fainter, that begins the fit of an ague. But on this instance I look not, as a strong proof of the physical efficacy of sounds; because those two verses having been emphatically read, when divers years ago I lay sick of a slow fever, and could not rest, they made so strong an impression on me, that whenever I am under a discomposure any thing near like that, that then troubled me, those verses revive, as it were, in my brain and some other parts, that disposition, or rather indisposition, with which my first hearing of those verses was accompanied.

It may be the less admired, that the vibrating motion of the air, that produces sounds, should have such effects upon disposed organical bodies; since light itself, which either consists of briskly moving effluvia, far more subtile than aerial corpuscles, or is propagated by the pulse of a far more subtile body than air, may have a notable operation upon disposed bodies: for we commonly observe, that the sun-beams, by
beating

beating upon the face or eyes of some, that come suddenly out of a shaded place into the light, presently make them sneeze; which, you know, is not done without a vehement motion of divers parts of the body. And though colour be but a modification of light; yet, besides that it was antiently a practice, as the history of the *Machabees* informs us, to shew red objects to elephants, to make them more fierce, it is a familiar observation, that red cloaths do offend and irritate turky-cocks. And that is more remarkable, which is related by the very learned physician *Valesus*, of a person, that he knew, who, if he looked upon red objects, would not only have his eyes offended, but was subject to an effusion of humours in the neighbouring parts.

C H A P. VII.

O B S E R V A T I O N VI.

Men suspect not, what efficacy the invisible motions of fluids may have, even upon inorganical bodies, upon the score of some determinate congruity or relation betwixt a peculiar texture of the one, and the peculiar modification of the other's motion.

THOUGH the experiments delivered in the foregoing chapter have, I presume, sufficiently manifested, that the modification given to the motions of the air by sonorous bodies may have considerable effects upon animals, in whose organized bodies the curiously contrived parts have an admirable connexion with, and relation to one another, and to the whole symmetrical fabrick they make up; yet, I fear, it will scarce seem credible, that sonorous motions of the air, not very loud, should find, even in bodies inanimate and inorganical, such congruous textures and other dispositions to admit their action, that even more languid sounds, peculiarly modified, may sensibly operate upon them, and much more than sounds, that are louder and more vehement, but not so happily modified. To make this good by particular experiments, I shall begin with that, which, though the effect may seem inferior to that of most of the others, I judge fittest to manifest, that the produced motion depends upon the determinate modification of that of the impellent fluid.

THAT a certain impulse of air, made by one of the unison-strings of a musical instrument, may suffice to produce a visible motion in another, is now become a known experiment; of the cause and some unobserved phaenomena of which I elsewhere more fully discourse. But, that it may not be suspected in this case, that the shake of the untouched string is communicated to it by the propagated motion of the instrument itself, to which the string, that is struck, is also fastened; I shall add, that, according to what I elsewhere relate, I found by trial purposely made, that a string of wire, (which you will grant to be a more solid body, than an ordinary gut-string) may be, without an other string, brought to tremble by a determinate sound made at a distance, which produced but such an impulse of the air, as could neither be seen nor felt by the bystanders, nor would communicate any sensible motion to the neighbouring strings. It is true, that in this case the string, in which the trembling was produced, was a single, long, slender and springy body, fastened at both ends to a stable one; and therefore it may seem altogether groundless to expect, that any thing like this effect should be by the same cause produced in bodies, that do not appear so qualified. But, as we elsewhere shew, that a certain degree or measure of tension is in order to this phaenomenon the principal qualification, without which all the other would be unavailable; perhaps it will not be absurd to enquire, whether,

in bodies of a very differing appearance from strings, the various textures, connexions and complications, that nature or art, or both, may make of the parts, may not bring them to a state equivalent to the tensions of the strings of musical instruments, whereby divers of the mentioned parts may be stretched in the manner requisite to dispose them to receive a vibrating motion from some peculiar sounds; and whether these trembling parts may not be numerous enough to affect their neighbours, and make, in the body they belong to, a tremulous motion discernable, though not by the eye, yet by some other sense. This conjecture, or inquiry, you will, I hope, have the less unfavourable thoughts of, when you shall have considered the following experiments.

I REMEMBER, that many years ago I found by trial, that, if a somewhat large and almost hemispherical glass, though not very thin, were conveniently placed, a determinate sound, made at a convenient distance from the concave surface of the glass, would make it sensibly ring, as a bell does a while after it has been struck: but this noise was the effect of a determinate sound; for, though the voice were raised to a higher tone, or if the sound were made louder, the same effect would not ensue. I remember also, that, some years after, I observed, that large empty drinking glasses of fine white metal had each of them its determinate tension, or some disposition, that was equivalent, as to our purpose. For, causing the strings of a musical instrument to be variously screwed up, and let down, and briskly struck, we found, as I expected, that the motion of one string, when it was stretched to a certain note or tone, would make one of the glasses ring, and not the other; nor would the sound of the same string, tuned to another note, sensibly affect the first glass, though perhaps it might have its operation upon another. And this circumstance is not, on this occasion, to be omitted, that, after we had found the tone proper to one of the glasses, and so tuned the string, that, (I say) when that was struck, the glass would resound. Having afterwards broken off a part of the foot of the glass, yet not so much, but that it continued to stand upright, the same sound of the string would no longer be answered by the vessel, but we were obliged to alter the tension of the string, to produce the former effect. The learned *Kircherus*, as I have been informed, somewhere mentions a correspondence between some liquors and some determinate sounds; which I suppose may be true, though the trial did not succeed with me, perhaps for want of such accommodations for so nice an experiment, as I could have wished, but could not procure: but if you can, you will oblige me to make the trials so, as to satisfy yourself and me, whether the agitation of the liquor be caused immediately by the motion of the air, or be communicated by the intervention of the tremblings of the vessel.

AN artist, famous for his skill in making organs, answered me, that, at some stops of the organs, some seats in the church would tremble. But because I suspected by his relation, that the greatness of the sound chiefly effected it, because when that pipe, which they call the open *diapason*, sounds, the chair or seat, on which the organist sits, and perhaps the neighbouring part of the organ trembles; I shall add, that I have divers times observed certain sounds of an excellent organ to make not only the seat I sat on in the church tremble under me, but produce an odd tremulous motion in the upper part of my hat, that I could plainly feel with my hands. And that, which makes me apt to believe, that this effect depends upon the determinate tone, rather than upon the loudness of the sound, is, that I have oftentimes felt, and diligently observed, such a kind of motion in the upper part of my hat, upon the pronouncing of some words in ordinary discourse; in which case the effect could not with

probability be referred to the greatness of the sound, but its peculiar fitness to communicate such a motion to a body so disposed.

NOR is it only in such small and yielding bodies, as hats and strings, that sounds, that are not boisterous, may produce sensible effects; for, if they be congruous to the texture of the body they are to work on, they may excite motions in it, though it be either solid or very bulky: of which I shall here subjoin a couple of instances.

AN ancient musician affirmed to me, that, playing on a base viol in the chamber of one of his scholars, when he came to strike a certain note on a particular string, he heard an odd kind of jarring noise, which he thought at first had either been casual, or proceeded from some fault in the string; but having afterwards frequent occasion to play in that same room, he plainly found, that the noise he marvelled at was made by the tremulous motion of a casement of a window, which would be made to tremble by a determinate sound of a particular string, and not by other notes, whether higher or lower.

To this first instance I shall add the second, which, I confess, I was not forward to believe, till trial had convinced me of the truth; and I scrupled it the rather, because, if the reflection of determinate sounds should appear to proceed from the peculiar kind of tremulous motion, into which the parts of the resonant body are put, it may incline men to so great a paradox, as to think, that such a motion of the air, as our bodies do not feel, may produce a trembling in so solid a body, as a stone-wall of a great thickness. The experiment or observation itself I shall give you in the same words I set it down some hours after I made it, which were these.

YESTERDAY I went to satisfy myself of the truth of what had been told me by an ancient musician, to whom I had been relating, what I had observed of the effects of some determinate sounds even upon solid bodies, and of whom I inquired, if he had met with any thing of the like nature: taking him along with me, I found, that though the place be but an arch, yet it would not answer to all notes indifferently, when we stood in a certain place, but to a determinate note, (which he afterwards told me was *Ce fa ut* a little flatted,) to which note it answered very resonantly, and not sensibly to others, which we made trial of, whether higher or lower than it: and (which added to the strangeness) when I made him raise his voice to an eighth; as consonant as those two sounds are wont to be in all other cases, the vaulted arch did not appear to us affected with the note. The musician added, that he had tried in most arches all about the city, and could not find such a peculiarity in them, as being to be made resonant by all notes or sounds indifferently, that were strong enough; and also, that as this arch for this hundred years has been observed to have this property, so an ancient and experienced builder informed him, that any vault, that were exquisitely built, would peculiarly answer to some determinate note or other.

C H A P. VIII.

O B S E R V A T I O N VII.

Men look upon divers bodies, as having their parts in a state of absolute rest, when indeed they are in a forced state, as of tension, compression, &c.

THIS observation will probably seem paradoxical; for when an intire body, especially if it be of a solid consistence, and seem to be of an homogeneous or uniform matter, appears to be moveless, we are wont to take it for granted, that the parts, which that body is made up of, are perfectly at rest also. But yet this will scarce

scarce be thought a reasonable supposition, if we do but rightly consider some obvious phenomena, which may teach us, that whilst a whole body, or the superficies, that includes it, retains its figure, dimensions and distance from other stable bodies, that are near it, the corpuscles, that compose it, may have various and brisk motions and endeavours among themselves. As when a bar of iron or silver, having been well hammered, is newly taken off of the anvil, though the eye can discern no motion in it, yet the touch will readily perceive it to be very hot; and, if you spit upon it, the brisk agitation of the insensible parts will become visible in that, which they will produce in the liquor. Besides, when the lath of a cross-bow stands bent, though a man do neither by the eye nor the touch perceive any motion in the springy parts; yet, if the string be cut or broken, the sudden and vehement motion of the lath, tending to restore it to the figure it had before it was bent, discovers a springiness; whence we conclude it was before in a state of violent compression. And though the string of a bent bow do likewise appear to be in a state of rest; yet, if you cut it asunder, the newly made extrems will fly from one another suddenly and forcibly enough to manifest, that they were before in a violent state of tension. And on this occasion I could add divers instances taken not only from the works of art, but those of nature too, if they did not belong to another paper: but one sort of observations it will be proper to set down in this place; because in those already mentioned, the bow and string were brought into a violent state by the meer and immediate force of man. I shall therefore add, that there are divers bodies, in which, though no such kind of force appears to have antecedently acted on them, we may yet take notice of a state of violent compression or extension, and a strong endeavour or tendency of the parts, that to the eye or the touch seem at rest, to shrink, or to fly out; and this endeavour may in some cases be more lasting and more forcible, than one would easily suspect or believe. But examples of this kind you must not expect that I should give you out of classick authors, since in them it is like you have not met with either an instance or a conjecture to this purpose; but some few things, that I tried myself, and some others, that I learnt by inquiry from some tradesmen, whom I judged likeliest to inform me, I shall briefly acquaint you with.

I HAVE sometimes observed myself, and have had the observation confirmed to me by the ingenious traders in glass, that a glass, that seemed to have been well baked, or nealed, (as they call it,) would sometimes, many days or weeks, or perhaps months, after it is taken from the fire, crack of its own accord; which seems for the most part to happen upon the score of the strong, but unequal, shrinking of the parts of the glass. And the glass-men will tell you, that if they take their glasses too hastily from the fire, not allowing them leisure to cool by degrees, they will be very apt to crack. But I remember, that, to satisfy some ingenious men, I devised a way of exhibiting a much more quick and remarkable phenomenon of that kind. Having made then, by a way I elsewhere teach, a flat lump of metalline glass, two or three or four times as thick, as an ordinary drinking glass, I observed, as I expected, that though it had been melted in a very gentle fire, its very fusible nature needing no other; and though it were removed but very little from the fire, it was so disposed to shrink upon a small degree of refrigeration, or rather abatement of heat, that, before it was sensibly cold, it would crack with a noise in so vehement a manner, that, notwithstanding the ponderousness of the matter, which had been purposely laid upon a level, parts of a considerable bulk, weighing perhaps some drams, would fly to a not inconsiderable distance from one another. And this experiment I took pleasure to make more than once. And if you will be content with an instance, which, though otherwise much inferior, may not be unwelcome, for its being easily and readily made, I shall

shall offer you one, that I have often repeated. Take a piece of copper, (if the plate be thick, it is so much the better,) and having thoroughly brought it to a red or white heat among kindled coals, take it from the fire, and when it begins to cool a little, hold it over a sheet or two of white paper, and you will perceive good store of flakes to fly off, not without some little noise, one after the other, and sometimes perhaps as far, as the farthestmost edges of the paper; which flakes or scales seem, by their brittleness and colour, to be but parts of the surface of the metal vitrified by the vehement action of the fire, and afterwards by a too hasty refrigeration shrinking so violently, as to crack and leap from one another, like the contiguous parts of the string of a viol or other musical instrument, that breaks by the moisture of the air. And on this occasion I shall add, that having afterwards inquired of an expert artificer, that made metalline concaves, about the shrinking of his mixtures of metals, he confessed to me, that he usually observed them to shrink upon refrigeration. And the like I myself have observed in iron of a great thickness, and purposely fitted to a hollow body of metal, which it would not enter when it was ignited, though it would when it was cold. But to shew you by a notable instance or two, both that metals may shrink, and that they may do so with a very considerable force, I shall add, that I found by inquiry, that the lately mentioned artificer, after he had made some large concaves of an unfit mixture of metals, and having removed them from the fire, had been very careful to keep the cold air from them, lest they should cool too hastily; observed yet, to his great loss, that, when they came to be further refrigerated, they would (perhaps after three hours) crack with a great noise, though this metalline mixture were perchance harder than iron, and three or four times as thick as common looking-glasses. But the misfortune of another tradesman afforded me yet a more considerable phenomenon. For this excellent artificer, whom I often employ, and with whom I was a while since discoursing of these matters, complained to me, that having lately cast a kind of bell-metal upon a very strong solid instrument of iron of a considerable superficial area, though the metal were suffered in a warm room to cool, from about eight o'clock on Saturday night till about ten or twelve on Monday morning, and were then (which is to be noted) considerably hot to the touch; yet it cooled so far, that, shrinking from the iron, that would not shrink with it, the bell-metal cracked, in divers places, with noises loud as the report of a pistol, though the metal, he affirmed to me, was an inch and an half, or two inches thick. And the same person shewed me a large cylinder of iron, about which, for a certain purpose, a coat of bell-metal had been cast some days before; on which (bell-metal) there was a crack near one end made by the coldness of the iron, though the thickness of the bell-metal, as near as I could measure it, exceeded an inch, and (as the workman affirmed) an inch and a quarter.

NOR is it only in such mixtures as bell-metal, which, though very hard, may be very brittle, but even in a metal, that is malleable when cold, that the like phenomenon may be met with, as I have been assured by another ingenious artificer, of whom I inquired, whether he had taken notice of the shrinking of metals; who affirmed to me, that having had occasion to cast about a cylinder of iron a ring or hoop of brass, he found, to his trouble, that, when the metal began to cool, the parts shrunk from one to another so, as to leave a gaping crack, which he was fain to fill up with solder quite cross the breadth of the ring, though this were above an inch thick.

I SHOULD not, *Pyrophilus*, have in this chapter entertained you with more experiments of others, than of my own, if I had the conveniency of living near founders of metals, as the tradesmen had, whose observations I have recited, and whose sincerity

in them I had no cause to question; and both their experiments and mine seem to teach, that a body may be brought into a state of tension, as well by being expanded and stretched by the action of the fire upon the minute parts, as by the action of an external agent upon the intire body. And, to speak more generally, the state of violent contraction and compression may not unfitly be illustrated by a bow, that is bent. For, as the bow itself is brought to a state of compression by the force of the archer, that bent it; so by the elastical force of the bent bow the string is brought into a violent state of tension, as may be made evident by the cutting off the string in the middle; for then both the bow will fly suddenly outwards, and the parts of the string will swiftly and violently shrink from one another. And, according to this doctrine, the effect of other bodies upon such, as are thus brought into, what men call a preternatural state, is not to be judged barely according to usual measures, but with respect to this latent disposition of the patient: as, for instance, though the string of a violin not screwed up will not be hardened by the vapours, that imbue the air in moist weather; yet a neighbouring string of the same instrument, though perhaps much stronger, being screwed up, and thereby stretched, will be so affected with those vapours, as to break with noise and violence. So when one part of a piece of glass is made as hot as can be, without appearing discoloured to the eye, though a drop or two of cold water have no effect upon the other part of the same glass, yet if it touch the heated part, whose wonted extension (as I have elsewhere proved) is altered by the fire, that vehemently agitates the component particles, the cracking of the glass will almost always presently ensue.

IF against these instances it be alledged, that it is possible to assign another cause of the seemingly spontaneous breaking of the bodies mentioned in this chapter, than that which I have proposed, it will not much concern this discourse to examine the allegation; for, whatever the latent cause of the phænomena may be, the manifest circumstances of them suffice to shew, that bodies, which as to sense, are in a natural state of rest, may be in a violent one, as of tension, and may have, either upon the score of the contexture of the parts among themselves, or upon that of some interfluent subtile matter, or some other physical agent, a strong endeavour to fly off or recede from one another; and that, in divers bodies, the cause of this endeavour may act more vigorously, than one would easily believe: and this suffices to serve the turn of this discourse; for I presume, that a person of your principles will allow, that local motion must be produced by local motion, and consequently, that, without a very strong, though invisible and unheeded one, such hard and solid bodies, as thick pieces of metal, could not be made to crack.

I KNOW not, whether I may on this occasion acquaint you with an odd relation I had from a very honest and credible, as well as experienced artist, whom I, for those reasons, have several times made choice to deal with about precious stones, and other things belonging to the jewellers and goldsmiths trades. For, considering with him one day a large lump of matter, which contained several stones, that he took for coarse agats, and which were joined together by a cement, that in most places was harder, than most ordinary stones, I perceived, that there remained divers pretty large cavities in this cement, which seemed to have contained such stones as those, that yet made parts of the lump; upon which occasion he affirmed to me, that several of the stones grew whilst they were lodged in those cavities. And when I told him, that though I had been long of an opinion, that stones may receive an increment after their first formation, yet I did not see, how any such thing appeared by those we were looking upon; he gave me in many words an account of his assertion, which I reduced to this; that the stones he spoke of, did, after they were first

first formed, really tend to expand themselves by virtue of some principle of growth, which he could not intelligibly describe; but that these stones being lodged in a cement extremely hard, and therefore not capable of being forced to give way, their expansive endeavour was rendered ineffectual, but not destroyed: so that when afterwards these stones came to be taken out of the cement, wherein they were bedded, and to whose sides it is like they were not exquisitely congruous, the compressed stones, having their sides now no longer wedged in by the harder cement, quickly expanded themselves, as if it were by an internal and violently compressed spring, and would presently burst asunder, some into two, and some into more pieces; of which he presented many to his friends, but yet had reserved some, whereof he presented me one, that I have yet by me, together with some of the mass, whose cement I find to bear a better polish than marble, and to be very much harder than it. And, in answer to some questions of mine, he told me, that he had taken up these stones himself, naming the place to me, which was not very far off, and that he observed all that he told me himself, and more than once or twice; and that I needed not suspect, as I seemed to do, that it was the strokes employed to force the stones out of their beds, that made them break: for, besides that many of them, which (it seems) were not compressed enough, did not break, several of those, that did, were taken out, without offering them any such violence, as that their bursting could with any probability be imputed to it.

C H A P. IX.

O B S E R V A T I O N VIII.

One main cause, why such motions, as we speak of, are overlooked, is, that we are scarce wont to take notice but of those motions of solid bodies, wherein one whole body drives away another, or at least knocks visibly against it; whereas many effects proceed from the intestine motions produced by the external agent in and among the parts of the same body.

THIS observation is like to be much more readily understood, than granted; and therefore I shall offer by way of proof the following experiments.

WE caused in a large brass stop-cock the moveable part to be nimbly turned to and fro in the contiguous cavity of that part, that was made to receive it, in that part of the instrument, that is wont to be kept fixed. And though this motion of the key was made only by the bare hand, yet in a short time the mutual attrition of the contiguous parts of the instrument made so brisk an agitation in the other parts, that the incalcescence made the metal itself to swell; in so much that the key could no more be turned, but remained fixed, as if it had been wedged in; so that, to make it work as before, it was necessary by cooling it to make it shrink a little, and so take off the mutual pressure of the key, and the other part of the stop-cock. Nor is this to be looked on as a casual experiment; for, besides that it was made more than once, and is very analogous to some other trials of mine; I found, that a maker of such instruments complained to me, that he was several times forced to intermit his work, and plunge his instrument in cold water, before he could, by grinding, adjust the key to the cavity it ought to fit.

I PRESUME I need not take notice to you, that this experiment confirms what I elsewhere mention of the dilatation of metals themselves by heat; and therefore I proceed to the next instance.

THIS is afforded by the known experiment of passing one's wetted finger upon the orifice of a drinking-glass almost filled with water. For, though the eye does not immediately discern any motion, that, by reason of the pressure of the finger, is made by one part of the glass upon another; yet, that a vibrating motion is thereby produced, may be argued by the dancing of the water, especially that, which is contiguous to the pressed sides of the glass, by which it is oftentimes so agitated, that numerous drops are made to leap quite over, and others are tossed up to a good height into the air. And that there may be considerable motions in the sides of the glass, whilst it does not break in pieces, we may probably guess by this; that in drinking-glasses artificially cut by a spiral line, both I and others have often found by trial, that a glass being dexterously inverted and shaken, the parts will vibrate up and down so manifestly, as sometimes to lengthen the glass, by my estimate, a quarter of an inch or more; and yet, the glass being set again upon its foot, it appeared, that it had not been hereby at all injured.

THAT two pieces of iron or steel, by being strongly rubbed against one another, will at length acquire a temporary heat, is not hard to be believed; but that an edged tool of hardened steel should, by having its edge rubbed against, have a manifest and permanent change made in its texture, you did not perhaps suspect: and yet, having had the curiosity to cause some metals, and particularly iron and steel, to be turned by an excellent artificer; I learned partly by his experience, and partly by my own, that the edge of the steel-tool, with which he by degrees shaved off the protuberant parts of the metal, would be so heated and agitated, that, in no long time, if care were not taken to prevent it, the tool would be brought to look of bluish and yellowish colours; and, permanently losing its former temper, would become so soft, as to be useless for its former work, unless it were again artificially hardened: and therefore, to prevent the trouble of tempering his tools again, this artist, from time to time, dipt it, when it began to grow too hot, into a certain liquor, which he affirms, upon much experience, to have a peculiar fitness for that purpose.

NOR is it always necessary, that the body, that makes the parts of an inanimate body work considerably on one another, should be either very hard, or impetuously moved. For I remember, that having once by me some short bars of fine tin, I resolved to try whether, merely with my naked hands, (which you know are none of the strongest or hardest,) I could not procure a considerable internal commotion among the parts; and accordingly, laying hold on the two ends of the bar with my two hands, I slowly bent the bar towards me and from me two or three times; and having by this means broke or cracked it in the midst, I perceived, as I expected, that the middle parts had considerably heated each other.

WHAT use may be made of this experiment, in the search of the hidden cause of elasticity, would be less properly considered in this place, than in another. But since I have named that quality, I shall take this rise to intimate, that if the restitution of a springy body, forcibly bent, proceed only (as some learned moderns would have it) from the endeavour of the compressed parts themselves to recover their former state, one may not impertinently take notice of the elasticity, that iron, silver and brass acquire by hammering, among the instances that shew, what in some cases may be done by a motion, wherein the parts of the same body are, by an almost unheeded force, put to act upon one another. But if springiness depend chiefly upon the pervasion of a subtile matter, as the *Cartesians* would have it, then the instances will properly belong to another subject.

§ THE foregoing examples may also suffice to make out (what I am unwilling to refer to another head) this subordinate observation; that men are more usually, than justly, prepossessed with an opinion, that nothing considerable is to be expected from the motion of a body against another, unless the former do make a manifest percussio or trusio of the latter. But, because this prepossession especially prevails in cases, where the body, that is by friction or attrition to affect the other, is itself soft or yielding, I shall on this occasion add a few instances to remove this prejudice.

AN artist eminent for grinding of optical glasses, confessed to me, that sometimes, when he went about to polish his broader glasses, though but upon a piece of leather sprinkled with puttee, that friction did so heat or otherwise agitate the parts of the glass, as, to his great loss, to make it crack from the edge to the middle; which seemed the more strange, because we see, what intense degrees of heat glasses will endure without cracking, if the fire be but gradually applied, as this artist's glasses must have been gradually heated.

BUT I think it worth inquiry, whether in this case the whole work be performed by meer heat; and whether there intervene not a peculiar kind of motion, into which some bodies are disposed to be put by a peculiar kind of friction, which seems fitted to produce in manifestly springy bodies, and perhaps in some others, (of which divers may be springy, that are not commonly taken to be so,) such a vibrating or reciprocal motion, as may have some notable effects, that are not wont to be produced by moderate heats, nor always by intense ones themselves. The trembling of the parts of a drinking-glass, and the visible vibration of the long and great strings of a base-viol, upon peculiar sounds, may give some countenance to this conjecture; and that in some bodies there may be such a tremulous motion produced, by rubbing them upon so soft a thing as wool, or upon a piece of cloth, I tried by this experiment:

WE cast into a hollow vessel, very smooth within, and of an almost hemispherical figure, several ounces of good melted brimstone; and having suffered it to cool, and taken it out, the convex surface, as had been desired, came off well polished: then this conveniently shaped lump, which had (if I well remember) four or five inches in diameter, being briskly rubbed in the same line forwards and backwards, upon a cushion or some such woollen thing, in a place free from other noises, I could, by holding my ear to it, and attentively listening, plainly hear a crackling noise made by the agitated parts, which continued a brisk, and, as I supposed, a vibrating motion for some time after the friction was ended.

THAT there may be a considerable commotion produced among the internal parts of bodies, by rubbing them even against soft bodies, I have divers times observed, by the sulphureous steams, that I could smell, if, after having a little rubbed a lump of good sulphur upon my cloaths, I presently held it to my nose: which brings into my mind, that I have had the like effect from much harder and closer bodies than sulphur, when they were rubbed upon bodies, that were so too; for having purposely taken hard stones cut out of men's bladders, and rubbed a couple of them a little against one another, they quickly afforded, as I expected, a rank smell of stale urine.

THAT diamonds themselves will, by rubbing upon woollen clothes, be made electrical, seems to argue, that even their parts are set a moving: and that the commotion reaches to the internal parts, I am the more apt to think, because I have a diamond, that, if I rub it well and luckily against my cloaths, will, for a little while, shine or glimmer in the dark; which is the same phenomenon, that I elsewhere relate myself

myself to have produced in the king's larger diamond, by giving it one brisk stroke with the point of a bodkin, where the light, that presently appeared in the gem, seemed not referrible to any thing so likely, as the sudden commotion made in the internal parts of that peculiarly constituted stone.

WHAT a peculiar modification of motion, distinct from its degrees of impetus, may do in fluid bodies, we have formerly in this essay taken notice of: but, perhaps, it may be worth while to inquire, what kinds there are of it, and what effects they may have in the parts of solid bodies themselves. For I have observed, that though those stones, that the Italian glass-men use, are very hard, and, if I misremember not, have several times afforded me sparks of fire by collision; yet, by rubbing them a little one against another, I found, that such an agitation was made in their parts, as to make them throw out store of foetid exhalations: and it is possibly to the stony ingredient that glass owes the quality I have observed in it, and elsewhere mentioned, of emitting offensive steams. And it is remarkable to our present purpose, that though so vehement an agitation of the parts, as is given to glass by heat, when it is made almost red-hot in the fire, does not make it sensibly emit odours; yet barely by dexterously rubbing two solid pieces of glass against one another, one may, in a minute of an hour, make those fixed bodies emit such copious steams, as I found, not only sensibly, but rankly, foetid; though one would think those stinking exhalations very indisposed to be forced off, since they were not expelled by the vehement fire, that the glass long endured in the furnace, where it was kept melted.

THERE are few things, that shew better, both how the parts of inorganical bodies communicate their vibrating motions to one another, and how brisk those motions are, than that, which happens upon the striking of a large bell with a clapper or a hammer. For though the stroke be immediately made but upon one part, yet the motion thereby produced is propagated to the opposite, and the successive vibrations of the small parts do, even in so solid and close a body as bell-metal, run many times round; as may appear by the durableness of the ringing noise, which seems plainly to proceed from the circularly successive vibrations of the parts, which, unless they briskly tremble themselves, can scarcely be conceived to be fitted to give the air that tremulous motion, whose effect on the ear, when the first and loud noise made by the percussion is past, we call ringing. And this motion of the parts of the sounding bell may be further argued by this; that if the finger, or some other soft body, be laid upon it, the sound will be checked or deadened, and much more, if a broad string, though of a soft substance, be tied about it. And not only an attentive ear may often make us guess, that the ringing sound is produced by a motion propagated circularly in the bell, but this vibrating motion may sometimes be also felt by the tremulous motion communicated by the trembling parts of the bell to the finger, that is warily applied to it. That this motion passes in a round from one side of the bell to the other, seems manifest by the great difference of sound, especially in regard of ringing, that may be observed in a sound bell, and in a cracked one; where yet all the matter and the former figure are preserved, only the intireness or continuity, which is necessary to the circulation (if I may so call it) of the tremulous motion, is at the crack stopt or hindered. And that the motion of the parts is very brisk, may be guessed partly by what has been said already; but much more, if that be true, which, not only is traditionally reported by many, but has been affirmed to me by several artificers, that deal in bells, who averred, as an experienced thing, that if a conveniently sized bell were bound about, any thing hard, with a broad string, and then struck with the usual force, that it would otherwise bear very well; that percussion would break it, giving a disorderly check to the brisk motion of the parts of
the

the bell, whereof some happening to be much more (and otherwise) agitated than others, the force of their motion surmounts that of their cohesion, and so produces a crack.

BUT, in regard great bells are not easy to be procured, nor to be managed, when one has access to them, I shall add, that I took the bell of a large watch, or very small clock, made of fine bell-metal, which had no handle or other thing put to it, save a little bodkin or skewer of wood, whose point we thrust into the hole, that is usually left in the middle of the basis; and this sharp piece of wood serving for a handle to keep the bell steady enough, we placed in the cavity of it, near the edges, (for that circumstance must not be omitted,) some black mineral sand, or, in want of that, some small filings of steel or copper, or some other such minute and solid powder, which yet must not be too small; and then striking moderately with the key against the side of the bell, we observed, (as we expected,) that, whilst it continued briskly ringing, it made many of the filings to dance up and down, and sometimes to leap up, almost like the drops of water formerly mentioned to skip when the brim of the glass was circularly pressed by the wetted finger: which prompts me to add, that, having put a middle-sized drop of water (for in this case the quantity is a considerable circumstance) near the lower edge of the bell, it was easy to make it visibly tremble, and be, as it were, covered over with little waves, by a somewhat brisk stroke of the key on the opposite side. And this effect was more conspicuous, when a very large drop of water was placed near the edge on the convex side of a hand-bell, whose clapper was kept from any where touching the inside of it. And to obviate their jealousy, that, not having seen the manner of the above-mentioned motion of the sand, might suspect, that it was produced by the impulse, which the bell, as an intire body, received from the percussio made by the key, we several times forbore putting in the filings, till after the stroke had been given; which satisfied the spectators, that the dancing and leaping of the minute bodies proceeded from the same brisk vibrations of the small parts of the bell, which, at the same time striking also the air, produced a ringing sound, which might very well, as it did, out-last the skipping of the filings; the exceedingly minute particles of the air, being much more easily agitable, than the comparative gross and heavy corpuscles of the powder. And this success our experiment had in a bell, that little exceeded an inch and half in diameter.

AND here, *Pyrophilus*, I shall put an end to this rhapsody of observations, hoping, that among so many of them, some or other will be able to engage you, if not to conclude, yet at least to suspect, that such local motions, as are wont either to be past by unobserved, or be thought not worth the observing, may have a notable operation, though not upon the generality of bodies, yet upon such as are peculiarly disposed to admit it, and so may have a considerable share in the production of divers difficult phænomena of nature, that are wont to be referred to less genuine, as well as less intelligible causes.

A SHORT
S U P P L E M E N T
TO THE
E S S A Y
OF THE
G R E A T E F F E C T S
Of even LAUGUID and UNHEEDED
L O C A L M O T I O N.

THAT I may not be altogether wanting to the expectation, that may have been raised by a passage in the advertisement prefixed to the foregoing essay, I shall here subjoin some particulars, which perhaps will not be unwelcome to the readers, that occurred to my remembrance, whilst I was, with a transient eye, reviewing the heads of the past discourse: but these paralipomena or supplements will be but few, not only because of my want of leisure to review the tract they belong to deliberately, but also because some instances, that might be here subjoined, may be more opportunely brought in in other papers.

To the third CHAPTER:

Borellus de
vi Percussio-
nis. prop.
CXI.

THAT the motion of the air, that accompanies sounds, may be propagated to great distances, and yet make considerable impressions on the bodies it finds there disposed to admit its action, may be notably confirmed by a phænomenon I have met with in the learned mathematician *Borellus*, who relates it upon his own knowledge, and not undeservedly magnifies it; which I shall therefore recite in his own words. *Aderam* (says he) *Tauromenii Siciliae, quando Etna mons eruptionem quandam effecerat propè Ennam, urbem fere 30. milliaria à Tauromenio distantem, tunc vicibus interpolatis eruptiones ingentes ignis vorago efficiebat, grandi sono & strepitu, & tunc omnia Tauromenii ædificia tremore concutiebantur, in quo circumstantiam notatu dignissimam observavi; scilicet, quod domus & ædificia, quæ directè exposita erant prospectui ejusdem voraginis, vehementissimè concutiebantur; reliquæ verò domus, quæ conspectu voraginis privabantur, satis lentè & leniter tremorem efficiebant.* Upon which matter of fact he thus argues: *Profectò, si hujusmodi tremor factus fuisset à concussione et resilitione soli Tauromenitani, omnes domus æquè concussæ fuissent, & æquali tremore agitatæ, ita ut non possit conspectus voraginis tam insignem et evidentem inequalitatem tremoris procreare; igitur necessariò à tremore ejusdem aëris incusso in parietibus domorum liberè percussiones excipientum, agitatio illa efficiebatur.* Videas hinc, (infers he) *quanta soni ad 30 milliarium distantiam efficacia sit.* “*Borel. de vi percussiois prop. CXI.* has these observable words: I was at *Tauromenium*”

“ *menium* in *Sicily*, when the mountain of *Ætna* broke out near *Enna*, a town distant about thirty miles from *Tauromenium*; whilst the gap did send out now and then, with a great noise, fire and flame, all the houses of *Tauromenium* were sensibly shaken; and it was observable that such houses, as looked directly towards the gap, were most of all agitated; those that looked otherwise shaking more slowly. Upon which matter of fact he argues thus: had this trembling been occasioned by the shaking of the ground of *Tauromenium*, all the houses had been equally shaken, since this inequality of motion could not be ascribed to their different situation: hence then we must needs conclude, that this agitation was produced by the impression of the air upon the walls of the houses, which demonstrates to us the great efficacy of a sound, though at thirty miles distance.”

TO the fifth CHAPTER.

THAT motion may be propagated far, through bodies of differing natures, may be inferred from what is mentioned in this chapter, especially about earthquakes: but because it may reasonably be suspected, that the active matter, which produces those stupendous motions, is dispersed into divers places, and may be of considerable extent; I shall here subjoin, out of the eloquent *Famianus Strada*, an instance, which is much the most memorable to my purpose, that I remember to have met with in history, to manifest to how great an extent a motion excited in a very narrow compass, perhaps but a very few fathom square, may be propagated through differing mediums, and one of them as solid as earth. This famous historian then having described a stupendous work, that had been with great skill and care made by the prince of *Parma*, to keep the city of *Antwerp*, which he closely besieged, from being relieved by the river *Scheldt*, (which, though not broad, is deep) proceeds to relate, that an engineer, who was a great master in his art, having undertaken to destroy this great work with a vessel (which I think we may call a floating mine) fraught with gunpowder, fireworks, &c. performed it with so tragical a success, that some Spanish officers, that were present, reckoned eight hundred to have been killed outright, besides a great number, that were wounded and maimed. But that part of the narrative, which comes home to our present purpose, is delivered in these words:

ON a sudden the fatal ship burst, with such a horrid crash, as if the very sky had rent asunder, Heaven and Earth had charged one another, and the whole machine of the earth itself had quaked; for the storm of stones, chains and bullets being cast out with thunder and lightning, there followed such a slaughter, as no man, but that actually it happened, could have imagined. The castle, on which the infernal ship fell, the pile-work of the bridge to *St. Mary's* fort, that part of the naval bridge next the castle, soldiers, mariners, commanders, a great number of cannons, armour, and arms; all these this furious whirlwind swept away together, tossed in the air, and dispersed as wind doth leaves of trees. The *Scheldt*, prodigiously gaping, was first seen to discover its bottom, then swelling above the banks, was even with the rampiers, and overflowed *St. Mary's* fort above a foot. The motion of the panting earth [*N. B.*] extended its force and fear above nine miles. [If he means the miles of that country, or Dutch leagues, they amount to thirty-six English miles.] There we found stones, and that very great ones, as, grave-stones, and the like, a mile off the river, struck into the ground, in some places, four palms.

Famian. Strad. de Bello Belg. Dec. 2. lib. 6.

To the sixth CHAPTER.

OBSERVATION I.

WHAT is delivered in this chapter about the operation of sounds and animals, particularly that which is mentioned (p. 19.) about the effect of musick upon serpents at *Grand Cairo*, may be not only confirmed, but exceeded by a strange relation, that I had from a person of unsuspected credit; which narrative having appeared to me so considerable, as well to deserve a place among my *Adversaria*, I shall subjoin that part of it, which concerns our present subject, in the words, wherein I find it set down.

Sir J. C. a very candid and judicious traveller, favouring me yesterday with a visit, told me, among other remarkable things relating to the *East-Indies*, (which countries he had curiously visited) that he, with divers European merchants, had seen (and that, if I mistake not, several times) an Indian, who, by many, was thought to be a magician, that kept tame serpents of a great bulk; and that when the owner of them played upon a musical instrument, these serpents would raise themselves upright into the air, leaving upon the ground but three or four inches of their tail, upon which they leaned for their support. He added, that at the same time, that they erected their bodies, they also stretched and lengthened them in a strange and frightful manner; and whilst they were thus slender, they were taller than he, or any man of ordinary stature. But that, which appeared to him the most wonderful and surprising, was, that they manifestly seemed to be very much affected with the musick they heard; insomuch that some parts of the tune would make them move to and fro with a surprising agility, and some other parts of it would cast them into a posture, wherein they seemed to be half asleep, and, as it were, to melt away with pleasure.

To the sixth CHAPTER, p. 20.

OBSERVATION II.

BECAUSE the truth, even of the principal effects of the biting of the tarantula, has of late been publicly called in question, I was glad to meet with an ingenious traveller, that in *Calabria* or *Apulia* was himself bitten by one of those venomous insects; and though it were but slightly, yet the effects he felt in his own body, and those greater ones he saw produced in other persons, that were more unhappily bitten, brought credit to the main of what sober writers affirm of the symptoms and cure of that poison. And the learned, &c.

To the seventh CHAPTER, p. 21.

MUCH of what is delivered in this chapter, and elsewhere, about the operation of air or invisible fluids (whose motions affect not the touch) upon congruous solids, may be confirmed by that notable experiment, which has been published in an elegant discourse by the learned *Morhofius*; about a Dutch wine-seller in *Amsterdam*, by name *Nicolaus Petterus*, who having found the tone or note peculiarly belonging to a large bellied drinking-glass, such as the Dutch call *Romer*, and many here call *Rhenish wine-glasses*, would, by accommodating his voice exactly to that tone, and yet making it loud and lasting, make the vessel, though not visibly touched, first tremble and then burst, which it would not do, if the voice were, though but a little, too low or too high. This notable experiment has been seen by many virtuosi, both before

before and since he published it. And the very ingenious writer, as he passed through *London*, not only related it to me, but very civilly offered me farther satisfaction, if I could furnish him with a *Romer*, which I was very sorry, that where we then were, was not to be procured.

To the eighth CHAPTER.

OBSERVATION I.

IT may add probability to some things delivered in this chapter, and in divers other passages of this treatise, if I here recount a strange phænomenon, that came into my memory, whilst I was running over those parts of this discourse.

THE phænomenon, in short, was this: having met with divers pieces of transparent glass, which I had reason to think to be of a texture or temper very differing from ordinary glass, I thought fit to try, whether some of them were not far more springy and brittle than their thickness would make one expect. And accordingly, though I found several, wherein the experiment would not succeed, especially if their figure were not convenient, yet with some others I had very good success, and particularly with some, that were shaped almost like the sharper end of the neck of a retort: for though these pieces of glass were much thicker than such necks are wont to be, being perhaps six or seven times as thick, as common drinking-glasses; yet I more than once made the trial succeed so well, that, by obliquely scratching them, or tickling them, if I may so speak, on the inside with the head or point of a pin, they would forcibly burst into many pieces in my hand. In which surprising phænomenon, the matter of the glass seemed to contribute something to this odd effect of so languid a motion, but much less than the texture, or tension, it obtained by the peculiar way of ordering it in the fire and the air.

To the eighth CHAPTER.

OBSERVATION II.

TO shew, that the suspicion I mention myself, a little before the end of this chapter, to have had, that the breaking of the stones there spoken of might possibly be produced or promoted by some impressions, remaining after the strokes employed to force the stones off their beds, was not altogether without ground;

I SHALL here observe, that it need not seem incredible, that faint strokes and attritions may leave more lasting and operative motions among the insensible parts, even of compact and solid bodies, than one would readily imagine: for I have several times found, sometimes by observations designedly made, and sometimes by undesigned accidents, that, having caused somewhat thin vessels of glass, especially urinals, to be diligently made clean with sand mixed with water, to loosen or grate off the foulness, that adhered to the sides of the vessel; though the vessels, after having been thus made clean, did not appear to have received the least injury, and would continue very intire perhaps for several hours, yet after that time they would, of themselves, break with noise, and thereby become unserviceable for the future. But though this happened to many urinals, yet because to more others it did not, it seemed probable, that the dissolution depended chiefly upon the peculiar texture of the glass in this or that vessel; whether acquired by a mixture of the ingredients, that was not uniform enough, or made in a due proportion, or else by the too hasty refrigeration of the vessel, especially if it chanced, as is not very unusual, to be cooled more hastily in one part than another.

OBSERVATION I.

BECAUSE there are divers gems, particularly those transparent ones, that are red or blue, that are much harder than iron or steel, it may much strengthen the proof of our eighth observation, if I here relate, that a jeweller to a great princefs answered me, that when he polished sapphirs, rubies, and some sorts of other hard gems, upon his mill, they would seem, when attrition had made them very hot, to be all on fire, like so many little coals; and that each of them had the light it afforded tinged with a colour proper to the stone; so that the ruby gave a red light, the sapphir a blue, &c. And I remember, that inquiring of a skilful cutter of diamonds and polisher of gems, whose customer I had been, about some conjectures I had concerning things belonging to his profession, he answered me, that sometimes, when he polished certain stones, especially rubies, that were pretty large, and perhaps not thick, he could plainly perceive, that the stone gaped at and near the edge, as if it were begun to be cracked; which sign admonished him to make haste to slacken the motion of the mill, lest the stone should absolutely burst; which if it did not, he could not perceive any flaw in it, when it was thoroughly cold; but, which was strange, it appeared as entire as ever. He added, in confirmation of what he had said of the intense heat, that gems would sometimes acquire, by attrition, whilst they were in polishing, that having lately given by this means too great a degree of heat to an oriental topaz, (which sort of that gem is very hard) it cracked upon the mill, insomuch that one part of it quite separated from the rest, and spoiled the stone in the capacity of a gem; as a proof whereof he had laid it aside for me, and would needs make me accept it as a curious, though not an useful, thing.

To the ninth CHAPTER.

OBSERVATION II.

TO confirm, what has been said in the eighth observation to shew, that slow and insensible intestine motions of the parts of a body, that seem quiescent, may be very operative, chance afforded me a notable instance, which was this. I had, to preserve a liquor, from which I expected a curious experiment, inclosed it in a strong vial; to whose neck a thick glass stopple was but too exquisitely adapted. This vessel I set upon the edge of a window, in a high and secure place, that it might not be moved. There it continued many months, or, if I misremember not, above a year; and the liquor was of such a nature, that if any body had, though but for a few moments, taken out the stopple, I could easily discover it. But, after all this while, one day, that I was sitting in my closet, at a good distance from the place, in which the vial stood, I heard a loud and brisk noise, almost like the report of a pistol, and then perceived that something came rolling to my feet: I hastily took it up, and found it to be the thicker and larger part of the stopple of my vial, which of itself had flown off, leaving the remaining part so closely and strongly adjusted to the neck, which served it for a kind of socket, that I could by no means pull it out thence. At this accident I was not a little surprized, considering the thickness of the solid glass, and that it had stood so long unmoved, and that the bigger and heavier part of the stopple broke off from the other with such violence, and was carried from it by invisible motors to so great a distance: which seemed the more strange, because there was no shaking nor treading in the room, that could put the parts of the glass into motion, there being nobody present but myself, who was sitting quietly and studying.

To the ninth CHAPTER.

OBSERVATION III.

TO confirm what I have in the eighth observation and elsewhere delivered about the latent motion of parts, that may be in a body not only quiescent but solid, I shall here add a strange instance, which was afforded me by a diamond, belonging to an ingenious merchant of that sort of gems, who brought many fine ones out of the *East-Indies*. For having, at the diamond-mine itself, purchased, amongst other stones that grew there, a rough diamond, that he valued at about a hundred pounds, and had well considered when he bought it; coming to look over his purchase again once more, about ten days or a fortnight after, he was much surprised to find, to his great loss, that this diamond had of itself cracked in several places, and so became of little or no value, but as it was a rarity: and indeed I could not without wonder see so fair and hard a stone so oddly spoiled with clefts, that seemed to penetrate so very deep, that it was guessed it would not be very difficult to pull the parts of the stone asunder. And on this occasion he told me, that he had admired this accident at first, much more than he did afterwards; for complaining of it to divers merchants and jewellers, that he met with in those parts; he was told, that though it seldom happen, yet it was no such wonderful accident, the like misfortune having befallen others as well as him.

A N
 EXPERIMENTAL DISCOURSE
 Of some UNHEEDED
 C A U S E S
 OF THE
 INSALUBRITY and SALUBRITY of the AIR:
 BEING
 A Part of an intended NATURAL HISTORY of AIR.

The P R E F A C E.

HAVING heretofore had occasion to draw together, under certain heads, divers unpublished observations and experiments of my own, and some of other men by way of memorials for a natural history of the air; I thought fit, by more largely treating of two or three of the subjects distinctly mentioned in my scheme of titles, to give a samplar or specimen of what may be done upon the other heads of the designed history. Upon this account I treated somewhat largely of the salubrity and insalubrity of the air, as a subject, which for the importance of it to men's healths and lives, I thought deserved to be attentively considered, and have its causes diligently inquired into. And having observed, that among the six principal causes of the healthfulness and insalubrity of the air; namely, the climate, the soil, the situation of the place, the seasons of the year, the reigning winds and contingencies (whether more or less frequent) and especially subterranean steams: having I say observed, that among these causes there was one, *viz.* the last named, about which I thought I could offer something, that I had not met with in the books of physicians, that treat of it; I was thereby invited to set down my thoughts and observations by way of conjectures, which I was made to believe would appear uncommon, and would not prove useless. These observations and reflections I referred, for clearness and distinction's sake, to four propositions: but when I had gone through the three first, and made some progress in the fourth, being hindered by divers avocations to make an end of it, I laid by the whole discourse in a place, which I thought a safe one; but when afterwards I had some opportunity to dispatch what remained, I found all the diligence I used to retrieve the entire manuscript unsuccessful. At this surprizing accident I confess I was somewhat troubled; because, whatever may be thought of the discursive part of those papers, the historical part contained divers matters of fact, that I did not meet with in books, nor can now distinctly remember, and will not perhaps be lighted on by even physicians, or such naturalists, as derive their knowledge only from them. It is upon this consideration, that having afterwards met with many papers, that belonged to most parts of the unhappy discourse, I thought fit to put them together in the best order I could, that I might not lose what might give some light to so important a subject as the theory of diseases. And this course I the rather pitched upon, because, before the papers about the salubrity of the air, I missed two other of my

manuscripts, whereof the former contained a collection of medicinal things, and the second a defence of the mechanical way of philosophizing about natural things, as it respects religion. And I remembered, that having formerly lost a manuscript I was much concerned for, I purposely made a noise of it; whence I supposed the plagiarist would conclude himself unable to make it pass for his: and in effect the book was in a while after privately brought back; so that I found it laid in a bye-place, where I had before as fruitlessly as carefully sought it.

AN EXPERIMENTAL DISCOURSE of some unheeded CAUSES of the INSALUBRITY and SALUBRITY of the AIR, &c.

THE sixth and last thing, upon which the salubrity and insalubrity of the air depends, is the impregnation it receives from subterranean effluvia. And though this be a cause not wont to be much heeded by physicians themselves; yet I take it to be oftentimes one of the most considerable in its effects.

THE effluvia, that pass into the air, may be distinguished into several sorts, according to their respective natures, as has been elsewhere shewn: wherefore I shall now only take notice of the differences that may be taken from place and time; upon which account we may consider, that some of them arise from the crust (if I may so call it) or more superficial parts of the earth; and others have a deeper original, ascending out of the lower parts, and, as it were, bowels of the terraqueous globe. And to this difference taken from place I must add another, perhaps no less considerable, afforded by time; which difference relates chiefly to the second sort of steams newly mentioned.

OF the subterranean effluvia, some are almost constantly or daily sent up into the air, and those I therefore call ordinary emissions; and others ascend into the air but at times, which are not seldom distant enough from one another, and those I call extraordinary emissions; whether they come at stated times, and so deserve the title of periodical, or else uncertainly, sometimes with far greater, sometimes with far smaller intervals, and so may be called fortuitous or irregular. But though I thought it might render what I am about to say more clear, if I made and premised the two foregoing distinctions, yet because in many cases nature does not appear solicitous to observe them, but at the same time imbues the air with steams referrible to divers members of these distinctions; I shall several times, though not always, take the liberty to imitate her, and consider the effluvia of the terraqueous globe in the more general notion, that they are so.

I KNOW it is frequently observed, and usually granted, that marish grounds and wet soils are wont to be unhealthful, because of the moist and crude vapours, that the stagnating waters send up too copiously into the air. And on the other side, dry soils are, because of their being such, generally looked upon as healthy. Nor do I deny, that these observations do most commonly hold true. But yet I think, that besides what can be justly ascribed to the moist vapours, or dry exhalations, we have been speaking of; in many places the healthfulness and insalubrity of the air may be ascribed to other sorts of effluvia from the soil, than those, that act merely, or perhaps principally, as these are either moist or dry.

PROPOSITION I.

TO deliver my thoughts about this matter somewhat more distinctly, I shall lay them down in the four ensuing observations or propositions, whereof the first shall be this: It seems probable, that in divers places the salubrity or insalubrity of the air,

air, considered in the general, may be in good part due to subterranean expirations, especially to those, that I lately called ordinary emissions. For in some places the air is observed to be much more healthy, than the manifest qualities of it would make one expect: and in divers of these cases I see no cause, to which such a happy constitution may more probably be ascribed, than to friendly effluvia sent up from the soil into the air; which particles, either by promoting transpiration (that great instrument of health and recovery;) or by hindering the production, or checking the activity of morbidic ferments; or by mortifying or disabling some noxious particles, that would otherwise infest the air; or by other ways, that I shall not now stay to enumerate; may not a little contribute to keep the bodies of those, that live in that air, in that regular and desirable state we call health. I know indeed, that it is generally thought, and often true, that mineral bodies do send up exhalations, hurtful not only to plants, but to men; but when we mean subterranean things indefinitely, though men are wont to look upon them but slightly, under a general confused notion, we employ a word more comprehensive, than most men are aware of, there being a great variety, (as well as multitude of bodies, that nature has lodged in her dark store-houses under the surface of the earth: and of these differing sorts of bodies, though it is probable, that the greatest part are such, whose effluvia are unhealthful to men, yet there may be others, whose emanations may be friendly to him. I have known it observed, that over some tin-mines in the western parts of *England*, not only trees, but far more tender plants, as grass, are wont to prosper and flourish; and (if I much misremember not) I have seen verdant trees growing just over a vein of another sort of mineral, that lay near the surface of the earth: and it is likewise observable about those, that constantly dig in those tin-mines, that they do not lead a short and sickly life, as in many others, but arrive at a great and vigorous age. And an ancient possessor of some of these mines being asked by me, whether amongst the otherwise differing exhalations, that ascended into the air, he did not find a difference as to smell, bad or good: he answered, that though most of those visible fumes had a smell, that participated enough of sulphur or bitumen to be offensive, yet some others were so far from being ungrateful, that they were well scented. And, on this occasion, I remember, that not long since a friend of mine and another virtuoso being partners in a chargeable attempt to discover a mine, in digging deep for it, they accidentally broke into a vast subterranean cavern, into which because the diggers would not venture to descend, one of these curious gentlemen caused himself to be let down, and there found the air very temperate and refreshing, and that he long breathed it with delight; and on the floor, or soil (which reached farther than he could discover) he found many and various minerals, most of them embryonated, or imperfectly formed, and store of a kind of mineral earth, whose smell was fragrant and very pleasant, both in his judgment and that of some ladies. And though, when some of these minerals were brought to me, a small lump of this earth, that was among them, had been kept so long in the air, as to spend most of its odoriferous particles, yet the smell it still retained was, though but faint, yet pleasing.

THAT from fossiles that lie hid under the surface of the earth, and have a considerably large spread, there may ascend store of wholesome effluvia into the air, seemed to me the more probable by what I noted at my last being in *Ireland*; where, being invited by a brother of mine to pass some time in a country house of his, to which there belonged a very large sheep-walk, that produced short, but excellent grass; I learned (and was easily persuaded by some things I took notice of) that this place was justly reputed very healthful: and this salubrity of the air, together with the sweetness of the grass, some circumstances invited me to ascribe to this; that the soil was sustained by a

large tract of limestone, which I supposed to emit continual exhalations into the air; which conjecture will perhaps with the less scruple be assented to, if I add, that it has been long and generally observed, that, as far as the limestone extends, that tract of ground makes the snow, that falls on it, thaw or melt much sooner, than it does on the neighbouring lands.

AFTER I had made this observation, I mentioned it in discourse to an inquisitive person, that had seen and been employed about several mines; and I asked him, whether he had met with any thing of this kind: to which he answered me, that in *Derbyshire*, at a place, which he named to me, he and others had observed, that a large tract of limestone land was so warm (as they speak) as to dissolve the snow, that fell on it, very much sooner, than another great scope of land, which was divided from it but by a glin, where the soil did not cover limestone, but freestone.

AFTERWARDS discoursing of this subject with an ingenious person, that had visited the Hungarian and Bohemian mines; he told me, that during his stay among the former, he often walked abroad with the overseer of them, a famous and experienced mineralist, who delighted to breathe the fresh morning air upon some hills abounding with minerals; that his guide made him observe, that when they were over a tract of land, that afforded much of that noble ore (which by a German name he called *Rot-gulden ertz*) he found the smell to be pleasing, and the air refreshing: and whereas, in passing over some mines, he found himself molested by offensive fumes, he felt no such effect, when he was upon that scope of ground, under which there lay veins of cinnabar, or, if you please, a mine of quick-silver ore: and his antient guide told him, that next the *Rot-gulden ertz* before-mentioned, the soil containing these cinnabarine veins, was that, whose incumbent air was the most eligible for pleasantness and salubrity. And I the less wonder, that in some places the subjacent fossiles should impregnate the air with wholesome effluvia, because I remember I had the curiosity to ride many miles, (though in the depth of winter,) to see a scope of ground, that was famous for a good pottery; where, besides many other mineral earths, that I took notice of, there was a pit or groove, that reached, if I mistake not, fifteen or twenty feet beneath the surface of the ground; whence they dug up a kind of white clay so richly impregnated with subtile and noble parts, that it afforded a chymist or two of my acquaintance (for I had myself no opportunity to distill it) good store of a subtile spirit of a volatile and saline nature, which, upon trial, they highly extolled for its cordial and other virtues in physic: and which, by some peculiar mechanical trials I have made with it, I concluded to abound with a volatile salt, not unlike that of urine or hartshorn. And since by this instance we see, that some unsuspected fossiles may be enriched with medicinal and fugitive salts and spirits; it may reasonably be supposed, that these ascending into the incumbent air may highly conduce to the salubrity of it. And the curiosity I have had to examine chymically some boles, and other bodies, which are wont to be unregardedly comprized under the confused notion of earths, makes me suspect, that there may be far more species of salubrious fossiles, than many have yet taken notice of.

BUT peradventure you will much the more easily admit in general, that subterranean tracts of great extent may for a very long time send up into the air copious exhalations, not discernible by any of our senses, nor commonly suspected to be found in that body, if you please to consider with me (what I do not remember to have been taken notice of to this purpose) that the common air we live in, and breathe, does always abound, and for many ages has been impregnated, with the copious magnetic effluvia of the earth; which our industrious *Gilbert*, and after him some learned Jesuits and others, have proved to be a great, though faint magnet; and whose emanations,

nations, as they constantly steam through the air, I have elsewhere by particular experiments shewn to be capable of passing through the pores of glass itself, and acting almost instantaneously, and yet manifestly, upon bodies hermetically sealed up in it. But though from what has been said it may be inferred, that it is not improbable the salubrity of the air in some places may be chiefly, or at least in part, due to the wholesome expirations of subterranean bodies; yet, generally speaking, the air is depraved, in far more places than it is improved, by being impregnated with mineral expirations. And indeed, besides that among the minerals unknown unto us, there are many more that are noxious, than that are wholesome; the power of the former to do mischief is wont to be far more efficacious, than that of the latter to do good; as we may guess by the small benefit men receive in point of health by the effluvia of any mineral, or other fossile, known unto us, in comparison of the great and sudden mischief, that is often done by the expirations of orpiment, sandarach, and white arsenick; for that sold in shops is factitious, being made of orpiment sublimed with salt, yet it is found natural in some Hungarian and other mines. On which occasion I remember, that the ingenious person lately mentioned to have with his guide taken the air upon the hills of that mineral country, answered me, that, when his guide and he walked over some veins of these noxious minerals, he met with several odorous steams, which, though differing from one another, agreed in this, that they were all offensive to him; and particularly some of them by their unwelcome sharpness, and others by giving him a troublesome difficulty of respiration. I will not here urge those sulphureous steams, that so suddenly deprive dogs of sense and motion, in the Neapolitan *Grotta di Cani*: because there the exhalations are too much included, and, as it were, pent up: but it is very proper to alledge for my present purpose the *Aorni* or *Averni*, which are mentioned by good authors to be found, some in *Hungary*, and some in other countries; for in these places there ascend out of the earth such noxious and plentiful exhalations, as kill those animals, that draw in the air they infect; and some of them are able to precipitate even the birds, that fly over the caverns, that emit them. But there are a multitude of places, where it is not so manifest, that hurtful exhalations ascend into the air, and yet they really do so; there being in many places whole tracts of land, that near the surface of the earth abound with marchasitical minerals, as these do with a sharp vitriolate salt, which, together with the ill-conditioned sulphur, that they also plentifully contain, ascend into the air, and render it corrosive. On which occasion I remember, that, for curiosity's sake, I took some English shining marchasite, and caused a pound of it to be distilled in an earthen vessel with a good fire; by which means, notwithstanding its dryness, I obtained two or three spoonfuls of a limpid liquor, that smelled very strongly, like that, which the Helmontians call *gas sulphuris*; and which appeared manifestly to be of an acid nature, both by the taste, and by its readily corroding and dissolving unbeaten coral, even in the cold, to mention here no other tryals, that I made with it. And the mineral afforded me, together with this liquor, about an ounce and three quarters of inflammable sulphur, part whereof ascending (as may be guessed) in the form of very agile corpuscles, these fastened themselves all about to the inside of the receiver, and there composed divers thin coats, or films, as it were, of sulphureous matter sticking to one another; which at their first taking off, and for some time after, might be bent or folded like leaves of paper, but afterwards harden in the air. Mineralists, and some other good authors, mention divers places, as abounding with marchasitical fossiles; but I am apt to think they are far more common, than is vulgarly taken notice of; for I have met with them, where one would little expect them. And though in *England* all our vitriol (which is now plentifully vended into foreign parts) be made of vitriolate stones, or bodies, that pass for stones; yet that is not true, which our mineralists are

went thence to conclude, that there is no other vitriolate or marchasitical matter in *England*: for a famous dealer in fossiles having found a mine, which he knew not what to make of, and therefore carefully concealed, addressed himself to me, because, he said, he knew I would not betray or supplant him; and having at his desire taken a private view of what he had discovered, I presently found it to be a vein, that lay at some depth under ground, and ran along (how far I know not) like a vein of metalline ore, (and for such, upon that account, he mistook it) consisting of a black and heavy stuff, which, upon a few easy trials, I quickly found to be of a vitriolate nature; insomuch that, somewhat to my wonder, I was able to make it yield in a few hours store of pure vitriol, without any troublesome or artificial preparation.

PROPOSITION II.

It is probable, that in divers places some endemical diseases do mainly, or at least in part, depend upon subterranean steams.

UNDER the name of endemical diseases, I do not comprise those only, that are very peculiar to this or that country; as the plica is said to be to *Poland*, (whence it receives its name of *Polonica*;) or an odd kind of cholick in one part of *France*, (from which it is called *la Colique de Poitou*;) but also those, that are more rife in some countries, than in most others; such as agues in *Kent*, and in that part of *Essex* they call the *Hundreds*; the consumption (though that be an ambiguous name) in *England*, whence foreign physicians call it the *Tubes Anglica*; and fluxes of the belly in *Ireland*, where they are so rife, as commonly to pass under the name of the country disease.

THAT these endemical, or (if we may so call them) topical distempers, do in many places proceed from some excessive heat, moisture, or other manifest quality of the air; from bad diet, vulgar intemperance, and other causes, that have little or no connexion with subterranean reeks, I readily grant: but, that in some places the endemical disease may either be principally caused, or much fomented, by noxious effluvia, I am inclined to suspect upon the following grounds.

1. THERE are some places, in which the endemical disease cannot be probably imputed to any manifest cause; as he may perceive, that shall consider, how often it happens that the causes, which are assigned of such diseases, if they were the true ones, must produce the like distempers in many other places, where yet it is notorious, that they are not endemical.

2. THAT subterranean bodies may send up copious steams, of different kinds, into the air, has been already made out.

3. IT has been also shewn, that the matters, that send up these effluvia, may be of a large extent. And, I remember, on this occasion, that I have sometimes observed, and that in more countries than one, a whole tract of land, that abounded with minerals of one kind; and within no great distance, as perhaps a mile or a league, another large tract of land, whose subterranean part abounded with minerals of a very differing sort.

4. WE have also above declared, and it is highly probable from the nature of the thing itself, that those copious steams (saline, sulphureous, arsenical, antimonial, &c.) that impregnate the air, may very much conduce to make it hurtful to a human body, in the way requisite to produce this or that determinate disease; as I not long since related from the chymist, that visited the Hungarian mines, that in some places he found the reeks ascending from them into the air (though in an elevated place, and exposed to the winds) make him, as it were asthmatical, and give him a

troublesome difficulty of respiration. And here let me add an observation, which perhaps will not be thought fit to be slighted by physicians; namely, that some parts of the substance of the air (for I speak not of its heat, coldness, or other such qualities) do not only affect human bodies, or at least many individuals among them, as they are taken in by respiration, but as they outwardly touch the skin; and the skin being (as I have elsewhere shewn) full of pores, and those perhaps of different sizes and figures, those corpuscles, that get in at them, may have their operation, even upon the most inward parts of the body. To make this more clear and probable, because it is a thing of importance, I desire these things may be observed.

1. THAT when I speak of the air, I do not in this place understand that air, which I elsewhere teach to be more strictly and properly so called, and to consist of springy particles; but the air in its more vulgar and lax signification, as it signifies the atmosphere, which abounds with vapours, and exhalations, and, in a word, with corpuscles of all sorts, except the larger sort of springy ones; and many of them may be so small, and so solid, or so conveniently shaped, as to get entrance at some of the numerous orifices of the minute or miliary glandules of the skin, or at other pores of it. Thus, though paper be not pervious to the uncompressed elastical parts of the air, yet it may be easily penetrated by other corpuscles of the atmosphere; for I remember I have, for curiosity's sake, prepared a dry body, out of a substance belonging to the animal kingdom, which, being lapped up in paper, would, without wetting or discolouring, or any way sensibly altering it, pass in a trice through the pores of it in such plenty, as to have not only a visible, but a manifest operation on bodies placed at some distance from it. And though a bladder almost full of air, having its neck well tied, be held near the fire in various postures, the elastical air, though rarefied, or attenuated by the heat, will rather burst the bladder, (as I have more than once found) than get out at the pores; yet we have often made a certain substance, belonging to the mineral kingdom, that, if a bladder were wet or moist, (as the skins of living men are wont to be, would readily pervade it) and have a sensible operation, even upon solid bodies placed within it. This experiment (that I can repeat when I will) is therefore the more considerable to our present purpose, because in the bladder of a dead animal, the porosity may be well supposed to be much less, than it was in the animal when alive; in which state the parts of the human body are much more perspirable, than one would easily believe; partly because of the heat, that is continually diffused from the heart, and partly because of the copious steams, that are in perpetual motion, and keep the parts warm, moist and supple: and it is not to be pretermitted in our present instance, that the bladder of urine consists not of a single membrane, and is probably of a stronger texture, by reason of the subtile salt liquor it is instituted to contain, than many other membranes of the body, or the epidermis. And this is the first thing I would have noted.

THE next is, that whereas in the instances newly recited, and some others, that are by and by to be mentioned, the effects were produced when the ambient air, impregnated with mineral corpuscles, had but a very short time (perhaps not many minutes) to work upon the body exposed to it; in those countries, that are very subject to endemical diseases, the inhabitants are wont to live all the year long, and perhaps during their whole life, exposed to the action of the vitiated air: and how much a far shorter time will serve, to make the corpuscles, that rove in the air, penetrate into bodies of no very close contexture, may be guessed by the breaking even of the bigger strings of lutes and viols, by the numerous (though invisible) vapours, that get into them in rainy weather; and much more by the effects of such vapours, when insinuating themselves in swarms into the pores of a rope, they shorten it so forcibly, as to enable

enable it, by shrinking itself, to lift up and keep suspended considerable weights, as I have elsewhere shewn by trials purposely made. These things may render it probable, that, though in a small compass of time the noxious effluvia, that rove in the air, may be too thinly dispersed in it, to insinuate themselves in any considerable number at the pores of the skin; yet, by reason of the continual contact of the air, (especially as to the face, hands, and some other parts) which may last day and night for many months, or perhaps years, there may be opportunity for a considerable number of morbid particles to insinuate themselves into the cutaneous pores.

3. AND thus having once got entrance, they may by the capillary vessels, that reach to, or terminate at the skin, pass on to somewhat larger vessels; and so may get into the mass of blood, and by its circulation be carried to all the parts of the body; and so be enabled both to deprave the blood, and other juices themselves, and to gain access to any determinate parts of the body, which their peculiar shapes, figures, &c. qualify them to produce some particular distemper in. This whole doctrine may be made more probable, by what experience shews of the virtues of certain plaisters, especially mercurial ones, in distempers, that are not at all, or at least are not chiefly cutaneous; and (which comes more home to our argument) of the efficacy of peripata, and appensa, such as piony-root, blood-stone, lapis nephriticus, quick-silver in a quill, a dried toad in a cernet bag, &c. whereof though many answer not the characters, that are wont to be given of them, yet some of them experience has convinced me to be of greater efficacy than I expected. And much more activity may be presumed to be in divers noxious effluvia from subterranean bodies; as may be gathered from the effects of the mercurial girdles, that some unwary persons wear to cure the itch; and from what I elsewhere relate of the fits of the cholick, often produced in a friend of mine by the effluvia of masses of loadstone. And this last example may serve for a proof of another part of our hypothesis, by shewing, that mineral effluvia may not only be noxious in a general way, but may produce this or that determinate disease. That arsenical appensa, though much extolled by divers physicians themselves, and sold dear by empiricks, as (if worn near the heart) wonderful amulets against the plague, have (especially in some persons and circumstances) produced some of the noxious effects of arsenical poisons, and particularly caused in some, great faintness and dispiritedness, I find by the testimony of divers eminent physicians. To which I shall add a remarkable one, which may probably be referred partly to this third observation, as well as to what I lately delivered about the bad effects of mineral exhalations breathed in with the air they vitiated; and I the rather mention this case, because it is not only an odd one, but is a considerable argument to shew, that noxious mineral expirations may manifestly produce a determinate distemper in unlikely parts of the body. The observation is this; I knew, and on some occasions employed, a chymical laborant, that fancied that he could make a rare medicine out of red arsenick, (as some call what others stile sandarach,) which is thought to differ little from common orpiment, saving its being much higher coloured; this laborant then working long and assiduously upon this mineral, and rubbing it frequently in a mortar, came divers times to me, and complained of a disaffection he thence contracted in the organs of respiration; for which I gave him something, that happened to relieve him; which encouraged him to complain to me of another distemper, that, though not so dangerous, did often very much molest him; which was, that when he was very assiduous in the preparation of his sandarach, it would give him great pains, and (if I misremember not) some tumours too, in his testicles; and this, for aught I know, happened to him as long as he was earnest about that process; for the medicines, that had relieved him in his other distemper, did not remove this; and I hav-

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ing occasion to go for a while into the country, found him gone at my return. It may strengthen the conjecture lately proposed of the possible insinuation of effluvia, that rove in the air, at the pores of the skin, if I add, that I have had the curiosity to enquire of more than one traveller, that had visited the famous *Pico of Teneriff* (at whose upper part there are found scattered parcels of sulphur, and divers manifest tokens of a vulcano) whether the sulphureous steams (that I supposed to be copious near the top of the mountain) did not work upon the silver money they had in their pockets, and discolour it; to which he answered, that it was no uncommon observation to find, at men's return from visiting the top of the hill, that the money they carried about them was blackened, and that he himself had particularly observed it to be so; which might easily gain credit with me, who have divers times made a preparation of sulphur, which, even in the cold, sends out exhalations so penetrant, that having, for trial's sake, put some pieces of coin (which ought not to be golden) into a leather purse, they were able, and that not in very many minutes, to discolour manifestly the money, in spite of the interposition of the purse, that contained it. But I had a more considerable instance of the efficacy of the sulphureous expirations of the *Pico of Teneriff*, by a sober person, that is one of the chief directors of the famous *East-India Company of London*; who being questioned by me about some circumstances of his journey to visit the top of that stupendous mountain, answered me, that among other effects the sulphureous air had upon him, (who is of a very fine complexion) he found, at his return to the bottom, that his light-coloured hair had manifestly changed colour, and was in many places grown forked at the ends. These observations may make it probable, that mineral exhalations may not only affect human bodies, as they are drawn into the lungs with the air they swim in, but as they insinuate themselves into the pores of the skin.

ONE considerable objection I foresee may be made, against the proposition I have been all this while endeavouring to render probable; namely, that it is scarce conceivable, that in so many ages as endemical diseases have afflicted some countries, the subterranean matter, to which I do in great part impute some of them, should not be wasted and spent. I might perhaps, on this occasion, move a doubt, whether we have had such continued accounts of the temperature of the air of all the countries, where diseases are now endemical, as to know, that they have been always so; and that some of those diseases have not been worn out here or there, and some other have not of later ages begun to appear in this or that place: but contenting myself at present to have hinted this question, I shall not stay to discuss it, but proceed to offer three things, by way of direct answer to the objection.

1. And first, I think it very possible, that divers subterranean bodies, that emit effluvia, may have in them a kind of propagative, or self-multiplying power. I will not here examine, whether this proceeds from some seminal principle, which many chymists and others ascribe to metals, and even to stones, or (which is perhaps more likely) to something analogous to a ferment, such as in vegetables enables a little sour dough to extend itself through the whole mass; or such as, when an apple or pear is bruised in one part, makes the putrified part, by degrees, to transmute the sound into its own likeness; or else some maturative power, whereby an inanimate body may gradually admit of such a change, or acquire such qualities, as may be, in men's estimate, perfective of it, and perhaps give it a new denomination; as ananas in the Indies, and medlars, and some other fruits here in Europe do, after they are gathered, acquire (as it were, spontaneously) in process of time, a consistence and sweetness, and sometimes colour and odour, and in short such a state, as by one word we call maturity or ripeness; and so some metalline ores, and some mineral earths themselves, have been observed by mineralogists, to acquire, in tract of time, such a change, as to af-

ford some metal, or other body, which either it did not afford before, or at least did not afford so copiously, or so well qualified. This I have purposely made out in another paper; and the observation particularly holds as to nitre, which is thought to be the most catholick fossile we have, and to be at least one of those fossiles, that do the most plentifully emit effluvia into the air.

2. WHEN I consider, that even in those mines, that are accounted deep ones, the spades of men are not wont to reach to the ten thousandth part of the thickness of the earth between its surface and its centre, which yet is but its semi-diameter; I cannot but confess, that we know very little of the nature or constitution of the lower part of the terrestrial globe; since we know little or nothing experimentally, of what lies beneath that, comparatively, very thin crust or scurf, (if I may so call it) that human industry has been hitherto confined to. And upon this account, I do not think it absurd to suspect, that from the lower subterranean regions there may be, either continually, or periodically, emitted into the regions of mines (if I may so call it) great store and variety of mineral exhalations, which may continually repair the loss of those, that, from time to time, ascend out of the fossile region (as I may also call that of mines) into the atmosphere. But the things I could alledge to countenance this conjecture, must not be insisted on in this place; therefore I proceed to consider,

3. THAT bodies so heavy, and consequently so abundant in parts of solid matter crowded together, as minerals and other fossils are wont to be, may well be supposed capable, without destructively wasting themselves, to emit store of such minute particles, as effluvia, for an exceeding long time. This will be easily granted by him, that shall consider the particulars laid together in a small tract, that I purposely writ, about the admirable subtilty of effluvia; and it will be the more easily believed, if it be considered, how long some load-stones, severed from their mine, have been kept in the air, without any notable, or perhaps so much as sensible diminution, of their virtue. And this brings into my mind what an eminent physician, who was skilled in perfumes, affirmed to me about the durableness of an effluviating power, that was not natural to a metal, but adventitious, and introduced by art; for he assured me, that he had a silver watch-case, that had been so well perfumed, that, though he usually wore the watch in his pocket, it continued to be well scented sixteen years. The same person had a way of perfuming factitious marble quite through, whose grateful scent he affirmed would last exceedingly; and of this perfumed marble he presented me a ball, which having been some months after gotten from me by a great lady, I was disabled from observing the durableness of the fragrancy.

I MIGHT perhaps be thought wanting to my cause, if, before I dismiss the proposition I have been all this while discoursing of, I should not observe, that subterranean effluvia may contribute to endemical diseases, not only as they vitiate the air that men breathe in, or are immediately touched by; but as they may impregnate or deprave the aliments, that men feed upon. For first, they do mingle themselves with the water, which either men drink itself alone, (as is the custom with many nations, and of some men in most nations;) or make of it their beer, ale, or other factitious drinks, prepared of water and barley, oats, rice, &c. That divers springs and other waters are imbued with mineral corpuscles, may be judged by some of the medicinal springs: for, though divers *acidulæ* and *thermæ* afford good store of palpable sulphur or salt, yet all do not; and having purposely examined a famous one, I could, with a pair of nice scales, scarce discover any sensible difference at all between the medicinal water and the common water, that was to be met with thereabouts: and that, which impregnated this, and which I found by trial on myself, and some other bodies, enabled it to work very manifestly like a mineral water, was a sort of corpuscles so mi-

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nute and subtle, that if the bottles were not kept well stopped, they would, in a short time, vanish, and leave the liquor dispirited. Experience has assured me, that there are ways of making common water violently and hurtfully operative upon human bodies, though its sensible qualities would not make one suspect any change in it; but the ill use that bad men may make of such liquors, makes me forbear to express myself more clearly; nor is it necessary that I should add any thing to confirm the proposed conjecture, save what may be inferred from these two particulars: the first whereof is the scarce at all sensible change, that may be made in water, and some other liquors, that are made strongly emetick by *crocus metallorum*, and by antimony vitrified without addition: and the second may be taken from those *Averni*, whence there continually ascend such pernicious exhalations, as in some places intoxicate or kill even the birds, that fly over those poisonous vents; for if such exhalations, or even far less deadly ones, should (as they may be reasonably supposed sometimes to do) meet with either running or stagnant waters in their ascent, there is little doubt to be made, but they will impregnate them, and make them noxious. And, on this occasion, we may pertinently recall to mind, what I have formerly delivered about a place upon the borders of *Lancashire*, where the water and mud of a ditch is so copiously impregnated with subterranean exhalations, (whether they be bituminous, sulphureous, or of some unknown kind) that they may easily be fired at the surface of the water or earth, and made to burn like a candle, as an ingenious man did, at my request, successfully try.

BUT there is another account, upon which the effluvia of the lower parts of the earth may have a greater stroke in producing of endemical diseases; namely, as they mingle with the water, and other liquors, that are necessary to the nutrition and growth of plants; and, by depraving those juices, make the vegetables, that are nourished by them, unhealthy for the men that eat them, or make drinks of them. And these noxious exhalations may be supposed in many places to impregnate the juices of the earth much more copiously, than they do the running or stagnant waters lately spoken of; because the difficulty of pervading the earth in their ascent may so long check them, as to make them very numerous in a small space, and perhaps make them convene into bodies so far of a saline nature, as to be dissoluble either in common water, or some other subterranean liquor; by whose help, as by vehicles, they may insinuate themselves into the roots of plants, and be thence conveyed to other parts. Divers things might be alledged to keep this conjecture from being improbable, if I had leisure to insist on them; but I shall now only mention two things, that on this occasion, come into my mind; the first whereof is, that inquiring of a famous chymist, who lived in a country abounding with mines of vitriol, whether he did not observe, that the oaks growing over them were more solid or heavy, than those trees are elsewhere wont to be; he answered me, that he did, and that the difference was remarkable: the other is, that the parts of some minerals, (probably by reason of the smallness and solidity of the corpuscles they consist of) are capable of insinuating themselves very plentifully into the pores of growing vegetables, without being really subdued by what philosophers are pleased to call the concocting faculty of the plant; and, instead of being assimilated by the vegetable, they retain their own mineral nature; and upon the recess or evaporation of the juice, that served them for a vehicle, may sometimes discover their being mineral, even to an unassisted eye; for I remember I have seen a piece of a vine, that grew not far from *Paris*, which being broken, I perceived a multitude of the internal pores of the root, and, if I mistake not, part of the trunk also, to be stuffed with corpuscles of a marchasitical nature,

as manifestly appeared by their colour, and their shining lustre, and also by their weight.

THERE goes a tradition among learned men, that the leaves of vines, that grow in some places of Hungary, whose mines afford gold, are, as it were, gilt on the lower side, by ascending exhalations of a golden nature. Whether this be true or no, I shall not take upon me to determine; but I remember, that having made enquiry about the truth of it, of a very ingenious traveller, whose curiosity led him to visit heedfully those famous mines; he told me, that he did not remember he had observed what is reported about the leaves of the vine; but he knew very well, that at *Tockay*, (a place that affords the famous wine of *Hungary*, and indeed the best I have drunk) very many of the kernels of the grapes would appear gilt over, as it were, with leaf gold. To what has been already discoursed, may be added, that since men are not wont to feed upon either beasts, or birds of prey, as carnivorous animals usually are, but upon such as live upon grass or seeds, or other vegetable substances, and drink nothing but fair water; the noxious exhalations, that make vegetables and water unwholesome, may, by their means, have a very bad influence upon sheep, cows, deer, pigeons, and other animals, that feed upon such depraved vegetables, and drink such noxious waters; and consequently may be very hurtful to those men, that feed upon such animals, and may, by the depraved aliment they afford, determine them to an endemical disease, such as that vitiated nutriment is fitted to produce.

PERHAPS it will not seem improper to add, on this occasion, that it is possible, that in certain places the latent minerals may be of such a nature, as that their effluvia may, instead of promoting, hinder the production of some particular disease, whether epidemical or endemical, in the bodies of them, that inhabit those places. For, as physicians observe, that the more manifest morbifick causes of some sicknesses are quite contrary to those of others; so I think it not improbable, that there may also be a mutual contrariety between those latent morbifick causes, that are sent up by subterranean agents: and therefore it need to be no wonder, if some of these should either disable those, to which they are hostile, or should at least work in human bodies a great indisposition to admit their hurtful operations; which methinks those physicians and chymists should easily grant, who, with a boldness that I do not applaud, prescribe amulets, wherein arsenick, or some other poisonous drug is employed, as preservatives from the plague; against which I doubt the chief succours they afford, proceed from the confidence or fearlessness they give those, that wear them. But to return to our subterranean effluvia; since there are divers whole countries, or lesser places, that are either altogether, or in great part, free from this or that particular disease; as in several parts of *Scotland* agues, especially, if I mistake not, quartans are very unfrequent; insomuch that a learned physician answered me, that in divers years practice he met not with above three or four; and in several large regions of the *East-Indies*, notwithstanding the excessive heat of the climate, the plague is very rare: since (I say) these things are so, it seems not altogether improbable, that the subterranean steams may contribute to this advantage, by impregnating both the air, the earth and the water, with corpuscles endowed with qualities unfriendly to these diseases; which seems to be somewhat the more credible, because it has been observed, that some vast tracts of land will neither breed nor maintain venomous creatures, as is undoubtedly believed of the whole kingdom of *Ireland*, where I confess I neither did see any alive, nor met with any other that did; for as to spiders, though they breed in that country, where I have seen many of them, and sometimes even upon Irish wood, yet they are unanimously believed not to be poisonous there. And some writers tell us, how truly I know not, of some other countries, to which they affirm the

like privilege to belong. But there is one instance afforded us by *Beguinus*, who travelled much to visit mines, which, if it be strictly true, is very notable for my present purpose. *Dignum admiratione est*, says he, *quod quamvis in vicinia Hydruntinis comitatus Gloriciensis, ubi reperitur copiosè &, singulis ferè annis lues pestifera grassatur, illa tamen semper immunis ab hac manere soleat, idque viri provecæ ætatis se observasse, et à majoribus suis accepisse, mihi sanctè confirmarunt.* “It is worthy our admiration, (says *Beguinus*) that though in the county of *Gloricia*, where a great quantity of mercury “is found, the pest almost every year raged, yet it is always free from the plague. And “this was confirmed to me by persons of a very great age, who said they had received it from their ancestors.” To which I should add the testimony of the learned *Michael Mayerus*, who pronounces the mercury to be an *alexipharma* against divers diseases, and particularly the plague, if I did not suspect, by his way of mentioning this last disease, that he borrowed his encomium of mercury from *Beguinus*. But however, what has been related has invited me to consider, whether there may not be some virtue, as well as some danger, in amulets of quicksilver, that are by many extolled against the plague: but this only upon the bye.

PROPOSITION III.

It is likely, that divers epidemical diseases are, in great part, produced by subterranean effluvia.

I AM very well aware, that divers diseases, that extraordinarily invade great numbers of people at the same time; (and were therefore by the Greeks called epidemical) may be rationally referred to manifest intemperatenesses of the air, in point of heat, cold, moisture, or some other obvious quality; and therefore the proposition speaks but of some epidemical diseases, and imputes those it speaks of to subterranean effluvia, not as total, but as partial, and sometimes as principal agents in the production of them.

IN favour of the proposed conjecture thus explained, I shall offer two things to consideration.

1. AND first, it seems not very improbable, that divers of those morbid excesses (especially if they be sudden) that are observed in the air, may proceed from the unusually copious ascent of hurtful exhalations, that mingle with the air, and diffuse themselves through it. We are greater strangers, than we commonly take notice of, to the subterranean part of the globe we inhabit: and if I had leisure, and thought it necessary, I could shew, that there are a great many odd and surprising things to be met with in the structure and disposition even of those parts of the earth that lye but a little way beneath the surface of it, and partly have been, and partly may easily enough be, actually penetrated by the industrious labours of men. And as for the deeper subterranean regions, we are so much more unacquainted with them, that we are scarce fit so much as to conjecture, how far they extend, or what kind of materials they contain; and what is the gross, and (if I may so speak) the mechanical fabric of the greater masses, whether solid or fluid, they consist of; and least of all can we determine, what motions, whether periodical, or others, these masses, or other portions of deeply lodged matter, may have.

ON such grounds as these I conceive it possible, that among the many and various effluviating bodies, that the terrestrial globe may conceal in its bowels, there may be some, whose reeks, ascending plentifully into the air, may occasion in it an excess of heat, cold, moisture, thicknefs, or some other manifest quality. So that sometimes (not to say many times) even those manifest intemperatenesses of the air, to which an
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epidemical disease is wont to be wholly imputed, (though perhaps not very justly) may in part proceed from subterranean bodies; for I elsewhere shew, that these, by their conflicts, or mutual actions on one another, may excite great and sudden heats, and on that account send up such copious steams into the atmosphere, as may produce there sudden and excessive heats, lightnings, thunders, &c. And I shall now add (what perhaps will appear somewhat strange) that I think sudden and unseasonable refrigerations of the air may proceed from the action of subterranean bodies upon one another: for trial purposely made has informed me, that there are certain minerals, whereof some may be employed in their crude simplicity, and the other requires but a slight preparation, such as it may have in the bowels of the earth; which minerals being put together, will produce, by their re-action, an intense degree of cold, not only as to sense, but when examined by a sealed weather-glass.

THE changes of the air, that produce epidemical diseases, are sometimes so great and sudden, that they cannot, in my opinion, with probability be imputed to the action of the sun or the moon (which are causes that act in too general, and too uniform a way, to have those particular and anomalous effects attributed to them) as probably as they may be to subterranean bodies, that often act with more suddenness and impetuosity, and without any regularity, at least that is known to us. The difference we find in seasons, that bear the same name, and should be alike in temperature, is oftentimes very great, and sometimes also very lasting. It is proverbially said in *England*, that a peck of *March dust* is worth a king's ransom; so unfrequent is dry weather, during that month, in our climate. And yet in some years, and particularly the last, it was a rare thing to have a shower either in *March*, *April*, or *May*. Sometimes in the month last-named, there are heats greater, than in the dog days of that same year; though usually here in *England*, divers mornings of that month are cold, and some of them frosty: and now and then I have observed in the same months and days, at no great distance from one another, that the weather has been sultry hot, and has also produced a great snow. We have seen summers like that, which is remembered for the siege of *Colchester*, that for almost the whole season were more dark and rainy, than several winters have been observed to be. To which purpose I remember, that when I was about to write the history of cold, I was fain to watch a whole winter to find two or three frosty days, to make an experiment or two I had need of, that required not a cold, that was either lasting or very intense. But instances of this kind are so obvious to those, that are at all heedful observers, that I may safely pass them by, and inculcate, that the sun, being in the same signs, at the same times of the year, it does not appear, how he should produce so great a disparity of the temperature of the air in seasons of the same denomination; (as the winters or the summers of differing, and yet perhaps immediately consecutive years.) And therefore I do not so much wonder, that many learned writers fly to astrology for an account of these irregular phenomena, and ascribe them to the influences of certain stars; notwithstanding what divers eminent philosophers, and some great astronomers too, have said to prove the vanity of judiciary astrology.

I SHALL not now stay to discuss the question, whether the stars have any influence distinct from their light and heat, because, my opinion about it being somewhat peculiar, I have discoursed of it in a paper by itself. But this I shall now say, that the fixed stars being but general, and (if I may so speak) indefinite agents, almost unimaginably remote from us, it is nothing near so likely, that such effects, as (besides that they happen very suddenly and irregularly) are oftentimes confined to a town, or some other narrow compass, should be produced by certain stars; as that they should be so by subterranean bodies, which are near at hand, of very various natures, and sub-

ject to many irregular and differing motions, commixtures, re-actions, and other alterations. I have known a great cold in a day or two, invade multitudes in the same city with violent, and, as to many persons, fatal symptoms; when I could not judge, (as others also did not) that the bare coldness of the air could so suddenly produce a disease so epidemical and hurtful: and it appeared the more probable, that the cause came from under ground, by reason that it began with a very troublesome fog.

THAT there may be many subterranean bodies, which by their commixtures may produce a sudden heat, will be easily granted by those that know, (what I elsewhere purposely make out) that there are subterranean menstruums, and are acquainted with chymical operations, such as the great effervescence made, when oil of vitriol is put upon filings of iron, or spirit of nitre upon butter of antimony: to which I might add many other of the like kind that I have tried; as when spirit of nitre is put upon filings either of iron, copper or tin, or upon crude quicksilver; which I shall content myself to have named, because I have another instance, that comes closer to our present purpose. For whereas I have shewn above, that there is in many places great store of marcasitical matter beneath the surface of the earth, and sometimes very near it; I shall now add, that I have purposely tried, that putting a little spirit drawn from nitre, (with which salt the earth in many places abounds) or a little oil of vitriol, upon powdered marcasites (which, being hard stones, are more difficultly wrought upon, than many other subterranean marcasitical bodies of a looser texture) there presently ensued a strong re-action between the liquid and the solid bodies, whereby was produced much heat, not without visible fumes, and strongly scented, though not visible, exhalations. And such kind of odoriferous effluvia were emitted upon the putting a little spirit of salt upon our powdered marcasites. And because sulphur is a mineral, that (either pure, or copiously mixed with others) is to be plentifully met with in the bowels of the earth, and in many places burns there; I shall add, that I have found acid spirit of sulphur (made the common way) to work sensibly upon marcasitical matter hard enough coagulated. An experienced German chymist relates, that in some parts of his country he met with vitriol stones, or marcasites, that, by the action of mere common water resting a competent time upon them, will grow so hot, as to enable the liquor to retain a sensible heat, when it had passed a pretty way from them. And, as I elsewhere shew, that many accidents may occasion the breaking out of waters, or the change of their course in subterranean places; so that common water may produce in a very short time considerable degrees of heat in mineral bodies, may appear by mixing with two or three pounds of fine powder of common brimstone, a convenient quantity, (for now I remember not well how much I took) of filings of iron; for this mixture being thoroughly drenched with common water, did in a short time grow intensely hot, and send up such a thick smoke, as good quicklime is wont to do, whilst men slack it with water.

It is observable to our present purpose, what account was given me by a domestic of mine, that lived in the north part of *England*, of a certain mineral groove, which he had often occasion to resort to: for when I asked, whether the damp, that place was molested with, did frequently recur; he answered me, that at the time he was there, it would annoy the workmen, (if they did not take good care of themselves), more than once in one day. And by inquiries, that I made of others, that were conversant in mines, I learned, that in divers places they were molested with damps, that came not at stated periods, but irregularly; sometimes with much greater, and sometimes with far lesser intervals between them; the times of their duration being also not seldom unequal. So that, supposing such noxious effluvia to be plentifully emitted from the lower parts of the soil, it need be no wonder, that an epidemical disease should

should be rise in this or that particular town or part of a country, without spreading much farther; and that it should begin suddenly in places, where it was not expected: for besides that these swarms of effluvia, being produced by casual concourses of circumstances, may oftentimes be excited, and invade this or that place, without giving the inhabitants any warning; besides this, I say, it is not always necessary, that these noxious effluvia should be generated just under the places they molest, since the motion of the air, especially when the wind sits favourably, may suffice to carry them to the town or other place, that feels their ill effects: and yet they may seem to be almost confined to those places; sometimes because the neighbouring places are not inhabited enough to make their ill qualities taken notice of; but more frequently, because, by being diffused through a greater tract of air, they are more and more dispersed in their passage, and thereby so diluted (if I may so speak) and weakened, as not to be able to do any notorious mischief.

AND here I consider too, that it is not always necessary, that the harm, that is done by these morbid constitutions of the air, should proceed only or precisely from these subterranean exhalations we are speaking of, by virtue only of their own qualities, which they bring with them from under ground. For it is very possible, that these effluvia may be in their own nature either innocent enough, or at least not considerably hurtful, and yet may become very noxious, if they chance to find the air already imbued with certain corpuscles fit to associate with them: for though these sorts of particles were perhaps neither of them apart considerably hurtful, yet there may from their combinations result corpuscles of a new and very morbid nature.

THIS may be somewhat illustrated by considering, that the spirituous steams of salt-petre are not wont sensibly to work on gold, nor yet the spirituous parts, that the fire raises from sal-armoniac; and yet when these two sorts of particles convene, there results from their coalitions certain corpuscles of a new nature, that compose the liquor chymists call *aqua regis*, which by its fretting quality corrodes and dissolves gold. By analogy to this we may conceive, that sometimes the subterranean effluvia may find the air already impregnated with such corpuscles, that, by associating themselves therewith, they may compose corpuscles far more capable, than themselves were whilst apart, of having ill effects upon the mass of blood, or some determinate parts of human bodies, and consequently of producing diseases there.

AND this instance may appear the more apposite; because it may be said, that as though silver and gold, and diamonds and rubies, &c. be put together, and *aqua regis* be poured upon them, it will leave all the rest uncorroded, and fall only upon the gold; so the newly-produced corpuscles, that I have been speaking of, whether breathed in with the air in respiration, or carried up and down by the blood, or other liquors of the body, may pass by other parts of it without doing them any sensible harm, and attacking this or that determinate part, produce there some disease, such as the fabrick and situation of that part peculiarly dispose it to be affected with.

AND I shall add on this occasion, that in our hypothesis we may render a probable reason, why in some epidemical diseases some persons may escape much better than others, that seem likely to be, at best, as obnoxious to them, without a recourse to the peculiar constitutions of the bodies of differing persons; for it may be conjectured, that the noxious corpuscles, that infect the air, may (especially in windy weather) be very unequally dispersed through the air, and many fly in far greater or lesser numbers within equal spaces of air; and consequently the persons, that have the ill luck to be in the way of the more numerous swarms of morbid corpuscles, may be much

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more prejudiced by them, than others, though of weaker constitutions, who happen to be attacked but by few of them.

ON which occasion I remember, that a great many trees in some land, that belongs to me, having been suddenly much endamaged by a wind, that was not able to do it by its bare strength; I had the curiosity to view somewhat heedfully a tree, that stood in the garden, and perceived, that all the considerable mischief was done to that side of the tree, which respected the corner whence the hurtful wind blew, the leaves of the other side continuing fresh and verdant, as being by the other part of the same tree fenced from the wind: and it was farther observed, that even the exposed side of the tree was not every where endamaged; for there were divers parts where the leaves continued sound and green, though neighbouring leaves, were some more, some less (for all that were prejudiced were not totally) blasted: the sound leaves and the discoloured being so oddly mingled, that I conjectured the cause of the mischief to have been this; that some arsenical, or other corrosive or poisonous exhalations, being suddenly emitted from the subterranean parts into the air, were by the wind they chanced to meet with there, hurried along with it, and blown against the bodies, that stood in its way, moving in the air like hail-shot discharged out of a gun, here in a closer, and there in a more scattering order; so that as more or fewer of them happened to fall upon the same branch or leaf, they left more or less marks of their passage, by destroying the texture and colour in the leaves, or parts of them they chanced to beat upon. And this may possibly be the cause of some of those sudden and sometimes fatal effects, that I have known in some places the people talk much of, complaining, that such a one had his eyes, or his face, or only one side of it, blasted by a malignant wind; of which I thought I saw an example in a domestick of my own, whilst in such a wind he was riding after me, who (thanks be to God) had no such mischief done me.

BUT the vulgar have entertained such strange conceits and stories about these blastings, on which account some of them say, that men are planet-struck, that the fabulous things mingled with those, that are possible, have made intelligent persons to reject them all.

ONE thing more I shall take notice of in favour of our hypothesis; which is, that it well agrees with what has been observed, not without some wonder, of the very short duration of some epidemical diseases in certain times and places. For this may proceed from hence; either that all the morbidic exhalations ascended into the air almost at once, or at least within a short time, and so were easily spent, that is, by diffusion or dispersion, so weakened, as to be disabled from doing much mischief; or else the subterranean commotion, that produced them, may pass on from one place to another, and so cease to afford the air incumbent on the first place the supplies necessary to keep it impregnated with noxious exhalations: and it agrees well with this conjecture, that sometimes we may observe certain epidemical diseases to have, as it were, a progressive motion, and leaving one town free, pass on to another. Of which some observations, that I have made, incline me to think, that if physicians would heedfully mind it, they might take notice of several instances.

ONE thing more may be added, as consonant to our hypothesis; namely, that sometimes an epidemical disease ceases in this or that place, almost as sudden as it invaded, or at least in a much shorter time, than physicians expected. For according to our hypothesis it may well happen, that after some sort of exhalations, whose peculiar qualities make them morbidic, have depraved the air incumbent on a particular place; there may, by a new or farther commotion of subterranean bodies, be sent up into the air store of exhalations of another kind, which meeting with those, that formerly

merly impregnated it, may either precipitate them, and so free the air from them; or by other operations on them, and sometimes even by coalitions with them, so alter their nature, as to disable them from doing any farther mischief.

THIS I shall illustrate, if not confirm, by that very remarkable phænomenon, that is yearly observed at *Grand Cairo* in *Ægypt*; for, (though I know not, whether or no the corpuscles, that produce it, arise from under ground, the affirmative part of the question being not improbable) it appears, that by the intermixture of adventitious corpuscles with the formerly pestilential air, it is so altered and corrected, that within one day or two, if not within a lesser compass of time, there is a stop put to the progress of the plague, that in the favourable time of year, namely, about the middle of summer, scarce ever misses of raging in that populous city: and, which is more admirable, these sanative corpuscles (if I may so call them) operate so powerfully, that of those, that are already seized by that fatalest of diseases, the plague, few or none die of it, after once these antidotal particles have sufficiently impregnated the air. I confess so great and sudden a change is very wonderful, and I should scarce think it credible, if I had not had the means and curiosity to inquire about it of divers persons, some of them very intelligent, that either curiously visited, or also made some considerable stay, in that great city, and found them agree in the main about the truth of the matter of fact: which is much confirmed to me by so eminent a testimony, as that of the learned *Prosper Alpinus*, who for several years practised physick in *Grand Cairo*, and as an eye-witness delivers what he relates more authentically, as well as more particularly, than any I have met with: and, though he endeavours to give several reasons of this strange and sudden cessation of the malignity of the plague, yet I doubt they are not sufficient for so wonderful an effect, unless we take in some new exhalations, that then impregnate and correct the air.

AND we shall scarce doubt of the great interest these have in the effect produced, if we give credit to what the recentest writer I have met with of voyages into *Ægypt*, has lately published about the annual pestilence at *Grand Cairo*, a city he much frequented. This author, in the account he gives of the present state of *Ægypt*, relates, that a little after the middle of our *June* (and usually upon the very seventeenth day) there begin to fall towards the last quarter of the night, near the morning, certain drops of a kind of dew, which causes the river to be fruitful, and purifies the air from all the infection of camfims, by which I presume he means the pestilence: for, after some lines interposed, he subjoins, *The drops or dew purifies the air, for as soon as it falls, the plague ceases to be mortal, none dies of it; the air is wholesome, all distempers cease, and if any person grows sick, he never dies.*

AND then, he adds, *This dew gives life to every thing; and when it falls upon the wheat, it causeth it to continue many years without corruption or worms, and is far more nourishing, than that corn, on which it never falls. For this cause they never house the corn of the Grand Seignior in the barns, till this dew is fallen upon it, that it might keep the longer without worms.*

As well this conjecture, as some other things delivered here and there in this paper (about the salubrity of the air) may probably gain the more credit, if I here subjoin, what I learned by inquiry from a very ingenious gentleman, who was owner of one or more of the mines, that afford the phænomenon I am to mention, which is this, that in the tin-mine countries in *Devonshire*, it sometimes happens, (as perhaps I may have elsewhere noted to another purpose,) that upon a sudden a spot of ground, and that not always narrow, will be, as it were, blasted by the ascending hurtful fumes; insomuch that not only the grass, fern, and other more tender vegetables, will be turned black, and, as it were, burnt or scorched up; but now and then trees
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also, without excepting oaks themselves, will be blasted and spoiled by the powerful operation of these subtle and poisonous effluvia.

It will probably be here expected, that among the epidemical diseases, that our hypothesis derives from subterranean effluvia, I should particularly treat of the cause of pestilential fevers, and the plague itself. But, though some such fevers may not improbably be in great part imputed to the noxious expirations of the globe we inhabit; yet as to the true plague itself, I freely confess I am at a loss about its origin.

THE sacred writings expressly teach, that some plagues, and particularly that, which in *David's* time swept away in three days 70,000 persons, have been in an extraordinary manner inflicted by God. And to me it appears either scarce possible, or far more difficult, than those, that have not attentively enough considered the matter, are wont to think it, to deduce the abstruse origin, strange symptoms, and other odd phænomena of some plagues, that are recorded in history, from merely corporeal causes.

ON the other side it seems unphilosophical, and perhaps rather seems, than is very pious, to recur, without an absolute necessity, to supernatural causes, for such effects as do not manifestly exceed the power of natural ones; though the particular manner of their being produced is perchance more than we are yet able to explicate. And I think it the more questionable, whether all plagues are supernatural exertions of God's power and wrath against the wicked, because I observe, that brutes (which are as well incapable of moral vice, as moral virtue) are yet oftentimes subject to murrains, such as may without incongruity be looked upon as the pestilences of beasts. And it is the less likely, that these sweeping and contagious maladies should be always sent for the punishment of impious men, because I remember to have read in good authors, that as some plagues destroyed both men and beasts, so some other did peculiarly destroy brute animals, of very little consideration or use to men, as cats, &c.

UPON these and the like reasons I have sometimes suspected, that in the controversy about the origin of the plague; namely, whether it be natural or supernatural, neither of the contending parties is altogether in the right: since it is very possible, that some pestilences may not break forth, without an extraordinary, though perhaps not immediate, interposition of almighty God, provoked by the sins of men; and yet other plagues may be produced by a tragical concurrence of merely natural causes.

BUT though the difficulties, that incumber each of the opposite opinions, keep me both from dogmatically asserting, that all plagues have a supernatural origin, and from denying, that any have it; yet, to say something on such an occasion, though I can speak but very hesitantly, I shall venture to add, that, whether or no the true plague be said to descend to the earth from a higher sphere, than that of nature; yet its propagation and effects are (at least for the most part) carried on mainly by a malignant disposition in the air; without which some plagues could never have been so catching, as they were, nor so suddenly mortal; and that in divers pestilences this malignant disposition of the air may probably be in great part imputed to some kinds of subterranean expirations, I am prone to think, and that chiefly upon two accounts.

THE first thing, that induces me to this conjecture, is, that not any of the several causes, to which the plague is wont to be imputed, seems to me to be sufficient. Those, that fetch it from the malevolent aspects and influence of the celestial lights, besides that they suppose some things, very difficult to be proved, have recourse to agents too remote, too general, and too indeterminate, to be acquiesced in as the causes of such particular symptoms and phænomena, as oftentimes accompany pestilences.

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And as for those other sects of physicians, that confidently derive the plague, some from internal putrefaction, and others from excessive heats, noisome stinks, corrupt aliments, and such other celebrated causes; though each party alledges plausible reasons for its own opinion, yet their objections against their adversaries are much stronger, than their arguments are for themselves. And the learned *Diemerbroeck*, though his own hypothesis seems to be more theological than philosophical, has much enervated the arguments brought for the several opinions lately named, and by him dissented from.

THE reasons he employs to refute all the received opinions about the origin of the plague, except his own, are divers of them worthy of so learned a man, to whom, though I had leisure to transcribe them, I should refer the curious; my present design being only to deliver some few things, that seem more favourable to my conjectures, than to his opinion, and were suggested to me, partly by my own thoughts, and partly by the informations, that, to examine those thoughts, I procured by consulting some uncommon authors, and asking questions of great travellers and navigators. By this means I came to learn, that divers great countries are usually free from the plague, that, according to the vulgar hypotheses, ought to be as much subject to it, if not more, than *England, France, Italy*, and those other parts of *Europe* and *Asia*, where that fatal disease rages from time to time in the parched regions of *Africk*, to which the excessive heats would make one expect, that the plagues should make far more frequent visits, than to our temperate European countries. *Leo Africanus* informs us, that some parts are so seldom afflicted with that dreadful disease, that it usually spares the inhabitants 29 or 30 years together. And he expressly records, that in *Numidia* itself, (if I much misremember not the country's name,) notwithstanding the raging heat of the climate, the plague is wont to be produced but once in a hundred years. Our * *Purchas* informs us, that in the land of the negroes it is not known at all. And to omit what some travellers and navigators relate of *Japan*, as if it were seldom or never invaded by the pestilence; I do not remember, that in *New-England*, which contains a great extent of land, though I have had both curiosity and opportunity to inquire after the diseases of that country, I ever heard the English take any notice of the plague, since their settling there above three score and ten years ago. And as for the *East-Indies*, Sir *Philibert Vernatti*, a virtuoso of great fame and authority at *Batavia*, where he resides, in his ingenious returns to the queries sent him by the Royal Society (of naturalists) answers thus to the fifteenth: [*Pestis morbus est Indiarum incolis incognitus.*] "The plague is a disease unknown amongst the Indians." And of the countries, that lie yet more remote, as the great empire of *China*, and the kingdoms of *Tunquin*, and of *Cochinchina*, that great traveller *Alexander de Rhodes*, who spent 30 years in those parts, affirms, that the plague is not so much as spoken of there: and yet the same Jesuit does, upon grounds probable enough, estimate the number of the people of *China* alone to be two hundred and fifty millions; [a number I take to exceed by far that of all the nations of *Europe*.] Now when I consider, how vast tracts of land are comprized in those countries, some of which the plague does not at all, and others but exceeding unfrequently, invade; this immunity seems to me very unfavourable to most, if not all, the opinions received among physicians, as also that of *Diemerbroeck* himself, who derives the plague from a supernatural cause, the wrath of God against the sins of men. For in regions of such extent, and divers of them very populous, which are seated under very differing climates, and which are some of them inhabited by nations, that make war with numerous armies, fight bloody battles, leave heaps of unburied bodies exposed to the putrifying heat of the sun; are sometimes forced, as well as others, to live upon very unwonted and unwholesome

* *Purchas's*
Pilgrimage, lib.
6. cap. 13.

foods; that worship stocks and stones, and beasts, and some of them devils, whom they know to be such; that are at least as guilty as Europeans, of assassinations, poisonings, rapes, oppression, sodomy, and other crying sins: in these regions I say, it is not imaginable, but that great intemperatures of the air, especially in point of heat, stench of dead bodies killed in fights, unwholesomeness of aliments, malevolent aspects of celestial bodies, high provocations of the divine justice, and in short all the causes, to one or other of which the several parties of physicians are wont to refer the plague, should be wanting any more than in our *Europe*; and yet the plague, which is presumed to be the effect of one or other of these causes, is not here observed to be produced.

I know, that it may be said, that the historical things I have been reciting do not only oppugn the several received opinions of physicians about the cause of the plague, but disavour my conjectures too. But if this be said, I desire it may also be considered, that my judgment about the plague consists of two parts: one, that it is exceeding difficult to assign the true and adequate cause of the origin of the pestilence; and the other, that whatever be the cause of its first eruption, its propagation, and divers of its symptoms, may be probably enough referred to the depravation of the air by subterranean steams, and their effects. If this be duly considered, the historical observations will appear not to overthrow the first member of our hypothesis, but rather to confirm it; and it is upon this account that I have mentioned them in this place: and as to the second member, it may be said, that since in the *East-Indies* and the other countries I have named, as privileged from this raging disease, it is not observed to break out; as it cannot be said, that subterranean effluvia do in those countries promote the propagation of it; so it cannot be proved, that they could not do it, in case the plague were begun by other causes. But in regard I think it not improbable, that sometimes the plague is not only fomented, but begun, by noxious exspirations of the terrestrial globe; I shall add, that this supposition, though I confess it to be somewhat disfavoured by some of the lately mentioned observations, yet is not absolutely inconsistent with them. For first, it may be said, that some of the countries I speak of, may be destitute of those noxious minerals, to which we impute some plagues, it holding true in minerals as well as in plants, *Non omnis fert omnia tellus*. And to omit what I have not without some wonder observed, of the limits of differing sorts of mines and mineral veins in very bordering parts of the same tract of land, I cannot but here take notice, that though sulphur be in many countries usually found, and that in plenty, where there are other metalline veins, insomuch that chymists make it one of the three principles of all metals; yet, in the mines of *England*, more strictly so called, I do not remember I ever met with so much as an ounce of native sulphur, and I could not find by divers mineralists, of whom I purposely asked the question, that they had met with any among the various mines they had frequented. It may also happen, that there may be hurtful minerals in a country, and yet not capable of often producing or promoting pestilences there, even upon moderate earthquakes. For it is possible, that these orpimental or other noxious minerals may have their beds or veins lying so deep in the earth, that they are not ordinarily able to send up effluvia strong and copious enough to make a pestilential depravation of the air; and even in lesser earthquakes the commotion or agitation of the ground, especially if the earthquakes proceed (as one may suspect, that divers of them do) from the sudden fall of ponderous masses in the hollow parts of the earth, and the shakings of the ground thereby produced, and sometimes spreading far, may not reach so far downwards, as much to affect these very deep mines, and yet some other more violent earthquakes may affect even these: upon which ground one may give some
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tolerable account, why the plague in some parts of *Africk* has been observed to rage but once in thirty, or once in a hundred years; for there may be periodical paroxysms, if I may so call them, or grand and vehement commotions in subterranean parts, though men have not yet, for want of sufficient longevity or curiosity, observed them. On which occasion I remember, that a late judicious French historian recounts, that in part of the last age, and part of this, a very pernicious disease of the nature of a cholick reigned in *France* every tenth year for a long tract of time. And the experienced * *Platerus* relates, that at *Basil*, where with great success he practised physick fifty-six years, the city was afflicted with furious plagues once about every tenth year for seventy years together, of each of which pestilences he gives a particular account in his useful observation. It may also farther be said, that those exhalations in the *East-Indies*, &c. that would otherwise be pestiferous, may be corrected by other expirations, that may be either of benign nature, or of such a nature, as, though noxious in themselves, may fit them, by combining with those, that would be pestiferous, to disable them to be so; as I elsewhere observed out of *Beguinus*, that a country abounding in veins and masses of cinnabar, which is the ore of quicksilver, was preserved from the plague, when the neighbouring regions were wasted by it. And I shall illustrate this matter somewhat farther, by taking notice, that though corrosive sublimate be so mischievous a mineral composition, that a few grains may kill a man, yet the fumes of this, combining with those of crude common quicksilver, which are themselves unwholesome enough, make *Mercurius dulcis*; which is a mixture so innocent, that being well prepared, and well administered, it is both safely and usefully given even to children.

* Lib. 2.
P. M. 323.

If what has been said will not suffice, I shall propose another possible way of accounting for the immunity of some countries from the plague. For one may conceive, that in such regions the soil, and other assisting causes, may constantly produce in the air such a constitution, as is found in the air of *Egypt*, during the time of the increase and overflowing of *Nile*, which usually lasts every year for several weeks; for during this time the air is so antipestilential, that not only the plague does not make a new eruption, but is either wonderfully checked or quite suppressed in those houses, that it has already invaded; so that its mortal infection reaches no farther. And that it may not be thought incredible, that some countries may have, if I may so speak, an antidotal nature, in reference to some pernicious evils, I shall represent, that there are some whole countries, which are privileged from producing vipers, toads, and other venomous creatures, as is vulgarly known concerning *Ireland*, where I could never see any such, nor find by enquiry of either the natives, or English inhabitants, that they had met with any in that kingdom, where it is uncontrolled tradition, that if poisonous creatures have been carefully brought there from other parts, they have died almost as soon as they came thither. There are some other islands, to which a like hostility to venomous animals is ascribed: and as it seems not impossible, that some countries should have a soil, that so impregnates the air, as to make it suppress, or quite enervate many different sorts of poisons; so others may, by their constitution, be qualified to master or resist poisonous expirations, or wandering corpuscles, that elsewhere are wont to produce the plague. And this may suffice for the first thing whereon we ground our hypothesis.

THE second thing that invited me to the above proposed suspicion or conjecture, is, that it affords a not improbable account of some considerable things, relating to the production and phænomena of the plague.

(1.) As first, it is observed, that sometimes the plague breaks out, when there has not preceded any such immoderate distemper of the air, or any casual enormity, capable

* *De abditis rerum caus.* lib. 2. c. 13.

pable of producing so great and anomalous an effect : nay, which is more, it has been observed, that very great and unusual intemperatenesses of the air have several times happened, and divers notable and threatening aspects of the stars have been noted by good writers without being followed by the plague. The celebrated * *Fernelius* relates, that near the time he writ this observation, that year, which of all those, that had passed in the memory of man, was all the world over the most immoderately hot, and was yet most healthful. And the same author reports the plague to have begun in the midst of winter, and to have gone off in summer, and that several times ardent summers have been altogether free from the plague; which I also have noted to be true. *Johannes Morellus* observes, that in his country, after a dry winter, and wherein the north wind reigned, though it were succeeded by a most temperate and healthful spring, yet this brought in the plague, and that when the north wind was predominant, and the air pure and serene: which I the less scruple to believe, because I observed something very like it in the constitution of the air, that preceded and accompanied the dreadful *London* plague, that broke out in the year 1665. Which phenomena much disfavour their opinion, that impute the plague to the excesses of the manifest qualities of the air; but are agreeable to our hypothesis, since by what has been formerly delivered, we may gather, that noxious subterranean fumes may be suddenly, and without any warning, belched up into the air, and, by depraving it, produce fatal diseases in many of those, that are constantly surrounded by it, and draw it in, almost every moment, with their breath.

See *Dierbroeck de peste*, lib. 1. c. 8.

OF the deadly hurtfulness of divers subterranean expirations, at their first eruption, there are many histories extant in approved authors; and we have observed instances of that sort in the times and countries we live in. But because all poisonous, and even mortal, exhalations, are not therefore truly pestiferous, but may, like many other poisons, kill the persons they immediately invade, without qualifying them to infect others; I shall add a passage out of that excellent historian, *Monfieur de Mezeray*, who relates in the life of *Philip de Valois*, "that the plague, that happened in France in the year 1346, was so contagious and destructive, that scarce a village, or even a house, escaped uninfected by it. He adds, that this pestilence, than which none had been observed more furious and spreading, began two years before in the kingdom of *Cathay*, by a vapour, that was most horribly stinking, which brake out of the earth like a kind of subterranean fire, consumed and devoured above 200 leagues of that country, even to the very trees and stones, and infected the air in a wonderful manner. From *Cathay*, says he, it passed into *Asia* and *Greece*, thence into *Africk*, afterwards into *Europe*, which it ransacked throughout." Other instances of pestilences begun by noxious subterranean fumes I have met with in good authors; but cannot now recal the particulars to mind, and therefore shall pass on to the second observation.

(2.) IN the next place then; whereas it is noted by diligent observers, that there is a wonderful diversity in several countries, and even in the same country at several distant times, of those raging diseases, that physicians agree in calling the plague, (whence it happens, that such medicines or methods of curing, as are in one plague successful, as phlebotomy, purging, &c. do oftentimes in another prove dangerous, if not mortal;) whereas (I say) this great variety has been observed in plagues, it may be fairly accounted for, by the great number and diversity, that has been actually found, or may be reasonably supposed, in the numerous minerals, and other bodies, that nature has laid up in the subterranean regions: especially if we consider, that the number of such bodies may be much increased or diversified by the various combinations, which may be made of them, not only by casualties, but by the action of sub-

terranean

terranean fires, and æstuaries, and menstrooms, such as I have elsewhere shewn to be lodged beneath the turf or superficies of the earth. And the ascending corpuscles of those mineral bodies, being most of them solid and subtilè, may produce in the blood, and so in the body, far more odd and violent symptoms, than the peccant humours, that use to beget ordinary diseases: which may be one reason, and perhaps the chief, why the ancient heathens, and *Hippocrates* himself, acknowledged in pestilential diseases *Σειον τι*, somewhat of divine, surpassing ordinary nature.

WHAT these mineral substances are, whose steams produce such odd and dismal symptoms, I think exceeding hard to determine; yet, if I were to name one sort, I should perhaps think the least unlikely to be orpiment. For, of the poisonous minerals we are acquainted with, I know not any, of which there is greater quantity in the bowels of the earth, especially taking that name in the latitude allowed it by those skilful men, that make three sorts of it, *viz.* yellow, red and white orpiment; divers of whose mischievous effects seem to agree well enough with the symptoms of some plagues, and may be guessed to have at least a considerable interest in the production of them. But yet, to speak candidly, I do not think, that these minerals are the causes, even of all those pestilences, whose efficient may come from under ground: for several reasons, and some drawn from experience, make me think, that the subterranean regions have many kinds of very mischievous fossiles, of which physicians, and even chymists, have no knowledge, and for which they have not any distinct names; and that the various associations of these, which nature may by fire and menstrooms make under ground, and perhaps in the air itself, may very much increase the number and variety of hurtful matters, and also heighten their hostility to human bodies; as I think may be argued from the factitious white arsenick, that is commonly sold in shops, which, though usually made of orpiment, by the addition of so innocent a body as common salt, (which is found in great plenty under ground,) is observed to be far more poisonous than orpiment itself. And I remember, that a skilful chymist having in my presence tasted some prepared, and, as was thought, somewhat corrected arsenick, was quickly invaded by such symptoms, as he thought would presently kill him; but, through God's blessing, I quickly put him out of danger, though not out of pain, by early prescribing him store of oil of sweet almonds, and something made of lemons, that I chanced to have by me. But to return to what I was saying, sandarach seems to be but orpiment, whose yellow colour is deepned to redness; and native arsenick, (for I have seen such a thing, tho' it rarely comes into *England*,) seems to be little other, than pale or white orpiment. And indeed in *Hungary*, all three may be found not far from one another in the same mine, as I learned by inquiry from an observing eye-witness, by whose means, and of another chymist, divers native orpimental minerals (to say nothing of realgar, because it is a factitious combination of orpiment and sulphur) came to my hands. And as this sort of fossiles comprizes more numerous and various ones, than is noted, so the very noxious effects of the effluvia of orpiment are not unknown to divers physicians: and the learned *Sennertus* Senn. M. P. E. vi. p. 66. gives a particular instance of it in a painter, who upon opening a box where orpiment, which men of his profession use as a pigment, had been long kept, had his face all swelled, and was cast into fainting fits. And as white arsenick is of a more piercing and corrosive nature, so it were not difficult to shew out of the writings of eminent physicians, that its effects have divers times proved very hurtful, and sometimes mortal, when but externally worn in amulets, especially if the pores of the skin were open by exercise and sweat; and the nature of the symptoms produced seems to confirm our hypothesis, since the persons that wore these arsenical amulets, were affected, some with great anxieties about the heart, some with inflammations, some with burning fevers, some with exulceration of the breasts, some with pustules like those

those of the plague, and these were sometimes black, as if made with a caustick: most patients were affected with great weakness and faintness, &c. as if they had swallowed poison; and of one young man it is recorded, that having heated himself in a tennis-court with an amulet upon his breast, the virulence of its corpuscles made him fall down stark dead upon the spot. And it is a considerable circumstance in these observations, that several patients were cured of the symptoms that seemed to be pestilential ones, by the same remedies that are alexipharmical against the plague: whence it may also be made probable, that the plague itself, many times is a natural, though a dreadful and anomalous disease, since its effects and symptoms so much resemble those of acknowledged poisons, and have been cured by antidotes effectual against other poisons.

I HAVE not time to mention, what I have myself tried and observed about the bad effects of orpiment, and its kinds. But I remember, that enquiring of an ingenious man, who sometimes visited a mine, which was known to abound with orpimental fossils; he answered me, that when he walked over the neighbouring grounds, he found himself much disordered, especially in his thorax, by the effluvia; and that the mine-men and diggers were subject to a malignant anomalous and dangerous sort of fevers, though he said he was apt to impute, I know not how truly, some part of their obnoxiousness to it, to their drinking too much strong wine. But though it is probable the effluvia of orpimental bodies may have a great interest in several plagues, yet I strongly suspect, that many others may proceed from the steams of such subterranean bodies, as are not yet distinctly known to us; and possibly have their effluvia variously combined, either beneath or above the surface of the earth: I say above; because I have several times, and that without heat, combined separately invisible fumes of differing kinds into manifestly visible ones in the free and open air.

AND that the subterranean effluvia may produce effects, and therefore probably be of natures, very uncommon, irregular, and, if I may so speak, extravagant, may appear in those prodigious crosses, that were seen in our time, viz. in the year 1660 in the kingdom of *Naples*, after an eruption of the fiery mountain *Vesuvius*; of which prodigies the learned *Kircherus* has given an account in a particular diatribe: for these crosses were seen on linen garments, as shirt-sleeves, women's aprons that had lain open to the air, and upon the exposed parts of sheets; which is the less to be admired, because, as *Kircher* fairly guesses, the mineral vapours were by the texture, that belongs to linen (which consists of threads crossing one another for the most part at or near right angles) easily determined to run along in almost straight lines crossing each other, and consequently to frame spots, resembling some one, and some another kind of crosses. These were extremely numerous in several parts of the kingdom of *Naples*; insomuch that the Jesuit, that sent the relation to *Kircher*, says, that he himself found thirty in one altar-cloth, that fifteen were found upon the smock-sleeve of a woman, and that he reckoned eight in a boy's band; also their colour and magnitude were very unequal, and their figures discrepant, as may appear in many pictures of them drawn by the relator; they would not wash out with simple water, but required soap; their duration was also unequal, some lasting ten or fifteen days, and others longer, before they disappeared. And these crosses were found not only upon linen garments exposed to the air, but upon some of those (belonging to altars) that were kept locked up in chests (to which possibly they might have access by the key-holes, or some unheeded chink.) To which strange phenomena, if I had the leisure to add some others, that I have met with in *Agricola*, and other approved authors, whose relations my memory doth not now serve me particularly to cite; I presume it would appear yet more probable, that subterranean effluvia may now and then be of

a very anomalous nature, and produce strange effects, and among them variety of pestiferous ones in the air.

BUT, to add this upon the bye, though I fear physicians will not be able to discover all the subterranean bodies, whose effluvia produce or contribute to the plague; yet, I do not think it impossible, that, by diligent observations and trials, sagacious men may discover divers of them, and perhaps antidotes against them.

AND though the business of this paper be to treat of the causes, not the remedies of the plague; yet I love mankind too well, to suppress on this occasion an observation, that, by God's blessing, may in some cases save the lives of many. In the late great plague, that swept away so many thousands in *London*, there staid in the city an ingenious physician, that was bred by the learned *Diemerbroeck*, (whose book *de Peste* I prefer to any I have yet read of that disease.) This doctor (whose name I am sorry I have forgotten) hearing, that I was desirous to receive an account of the plague from some intelligent eye-witness, and having soon after some occasion to pass near the place in the country, where I then resided, was pleased to give me a visit, and a rational account of the main things I desired to know; and when I inquired about his method of cure, after he had told me, that he had twice had the plague himself, whereof he shewed me some effects, he added, that after many and various trials he perceived, that abundance of his patients died, after the buboes, (carbuncles) or pestilential tumours appeared; because upon a little refrigeration of the body by the air, and oftentimes by the very fear, that disheartened the patient, the tumours would suddenly subside, and the pestilential matter recoiling upon the vital parts, would quickly dispatch the fatal work. Wherefore he bethought himself of a method, by means of which he assured me, he had not lost one patient of very many he treated, if he could but, as he usually did, by good alexipharmical, and cordial remedies, enable and excite nature to expel the peccant matter into a tumour; for then he presently clapped on an appropriated drawing plaister, which would never suffer the tumour to subside, but break it, or make it fit for an opening; and thereby give nature a convenient vent, at which to discharge the matter, that oppressed her. This plaister, it will easily be thought, I was desirous to know; and he told me it was a chymical one, and that it was no more than the *magnes arsenicalis* of *Angelus Sala*, whose description, because the book, wherein it is found, is in few hands, I have here annexed. If this prove as successful in other plagues, as it did to those, that used it in that of *London*, there will be just cause to admire and praise the benignity of divine providence, which in a poisonous mineral, that probably does oftentimes concur to produce the plague, has laid up a remedy for it.

Emplastrum attractivum pestilentielle nostrum.

R Gummi sagapeni, ammoniaci, galbani an. ℥ij. Terebintkinæ costæ, ceræ virginis ana. ℥ivss. Magnetis arsenicalis subtiliter pulverisati ℥ij. radic' Aronis pulverisat' ℥i. Gummi depurentur cum aceto scyllitico, & ad consistentiam emplastri coquantur, & postea ponderentur, deinde cum rebus aliis fiat emplastrum lege artis: hoc emplastro carbunculus obducatur, quod paucis horis venenum extrahit.

An attractive Pestilential Plaister.

“ TAKE of the gums sagapen, ammoniac, galbanum three ounces, of boiled turpentine and virgin-wax four ounces and an half, of the arsenical loadstone well pulverised two ounces, of *Aron's* root pulverised an ounce; let the gums be depurated with the vinegar of squills, and boiled to the consistency of a plaister, and
“ lastly

“ lastly weighed : then according to the usual method with other things make up a
 “ plaister ; cover the carbuncle with this plaister, and in a few hours it will draw out
 “ all the venom.”

Præparatio Magnetis Arsenicalis antea dicti.

R Arsenici ChrySTALLINI, sulphuris vitri antimonii crudi ana : hæc tria in mortario ferreo pulveriscentur in vase fortissimo vitreo : ponantur ad ignem arenæ, donec vitrum optime incalcescat, & prædicta solvantur & liquentur instar picis, quod observabitur, quando filum quoddam immititur in fundum, quod extractum postea instar Terebinthinæ trahetur ubi satis coctum erit : postea remove vitrum ab igne, & ubi refrigeratum est, rumpe, & subtiliter pulverisa, & ad usum serva.

The true preparation of the fore-mentioned arsenical loadstone.

“ TAKE equal parts of chrystal-arsenick, of sulphur of glafs, of crude antimony ;
 “ bray them to powder in an iron mortar, set them in a strong glafs on a fire of sand,
 “ till the glafs be very hot, and the fore-mentioned drugs melted like pitch ; which
 “ you shall know, when having thrust a thread into the bottom, the matter sticking
 “ to it does rope like turpentine ; which is a sign of its being well enough boiled :
 “ remove then the glafs from the fire, and when it is cold break it ; reduce the matter into small powder, and keep it for your use.

By the same motive, *Philantkropy*, I am induced to add on this occasion, that having had some opportunity to oblige an antient and very experienced physician, to whose care was committed a great pesthouse, where the contagion was so strong, that he lost three physicians, that were to be assistants to him, and three chirurgeons of four, that were to be subservient to him ; I desired to learn of him, if he counted it not too great a secret, what antidote he used to preserve himself from so violent and fatal an infection. This request he readily granted, but withal told me, that his method would not seem to me worth mentioning, if I were one, that valued medicines by their pompousness, not their utility. For, besides ardent prayers to God, and a very regular diet, his constant antidote was only to take every morning fasting a little sea-salt in a few spoonfuls of fair water ; which he made choice of, both because it kept his body soluble without purging or weakening it, and for other reasons, which I must not now stay to set down. I know this medicine may appear a despicable one : but yet, in my opinion, it ought not to be despised, after such experience, as I have related, has recommended it. For I think it desirable, that notice be taken of all remedies, that have been found by good trials, not bare conjectures, or uncertain reports, available against the plague : for, since pestilences, as we have lately noted, are exceeding various in their kinds, it is very possible, and not unlikely, that their appropriated remedies may be so too ; and therefore I would not easily lay aside every medicine, that this or that learned physician may speak slightly of, or even may declare, that he has found it unsuccessful against the plague ; since the same medicine may be available in a pestilence of another kind, in which perhaps the remedies commended by the physician we speak of, will be found inefficacious.

THIS consideration forbids me to pass by, what happened to me in the great *London* plague above-mentioned ; namely, that a very learned physician having once recommended to me an herb little noted in *England*, as a most effectual and experienced antidote against the plague, I caused it to be cultivated in a garden (as I still do every year ;) and when the pestilence raged most, having some of it by me made up with a little sugar in the form of a fine green conserve, I sent it to two infected persons, who,
 by

by the divine benediction on it, both of them recovered. But having made but those two trials, I dare not ground much upon them only; though I usually keep the plant growing in a garden, partly because both the taste and colour, one or other of which in most antidotes is offensive, are in this pleasant; and partly because some little experience has invited me to believe the commendations, that I have found given of it against the bitings of venomous creatures: whereof I remember a notable instance is recorded by *Petrus Spekreerius* of a Roman, who having with a staff pierced or crushed a viper, that he took to be dead, had so strong a venom transmitted along the staff, that the ensuing night he had a very great inflammation in both his lips, to which supervened an exceeding ardent fever, and strange tortures; from all which *Serianus Pacyonius*, a noted physician, that was called to him, freed him, as it were, by miracle, by the juice of goat's-rue, or, as others call it, galega, that grew copiously in that place. It may without disgust be taken somewhat plentifully, (and so it ought to be) in its entire substance as a salad; or else one may give its conserve, its syrup, or, which is better, its juice newly expressed.

*In obser-
vat. nobil.
apud
Schen-
kium, l. 7.
Observ.
Med. Tit.
de venenis
ex anima-
libus.*

(3.) It likewise agrees with our hypothesis, that sometimes the plague ceases, or at least very notably abates of its infectiousness and malignity, in far less time, than according to the wonted course of that ravenous disease, physicians did, or rationally could expect. For sometimes it may happen, that, though the temperature or intemperateness of the air continues the same, the matter, that afforded the pestiferous exhalations, may be either spent under ground, or so altered by combination with other subterranean bodies, or by some of those many accidents, that may happen, altogether unknown to us, in those deep and dark recesses. And if once the fountain of these noxious effluvia be stopt, so that those, that are in the air, cease to be recruited, the wind and other causes may in a short time dissipate them, or at least dilute them with innocent air, so far, as to keep the disease they produced from being any thing near so mischievous as before. And here I consider, that it may several times happen, that though the minerals that emit the hurtful expirations, remain where they were under ground, and be not considerably wasted; yet their fatal effects may not be lasting, because the effluvia were generated by the conflict of two or more of them, which vehemently agitated one another, and sent up fumes, which ceased to ascend, at least in great plenty, when the conflict and agitation ceased: as I have tried, that by putting good spirit of salt upon filings of steel or iron in a conveniently shaped glass, there will be made a great conflict between them; and without the help of external heat, there will be sent up into the air store of visible fumes of a very sulphureous odour, and easily inflammable; which copious elevation of fumes will lessen or cease, as does the tumultuous agitation, that produced them. And so likewise, if you pour *aqua fortis* upon a convenient proportion of salt of tartar, there will be at first a great ebullition produced, and, whilst that continues, store of red and noisome fumes will be elevated, but will not outlast the commotion of the mixture, whose active parts will in no long time combine into a kind of nitrous salt, wherein the noxious parts of the menstruum are as it were pinioned, and hindered from evaporating or ascending, though really they retain much of their pristine nature, as I elsewhere shew.

It may also happen, that soon after that commotion of subterranean matter, which sent forth pestiferous exhalations, a more intense degree of subterranean heat, or perhaps the same latent fire, extending itself farther and farther, may force up fumes of another sort, that being of a contrary nature, may be, if I may so speak, antidotal against the former; and by precipitating them, or combining with them, may disable them from acting so mischievously, as otherwise they would. To countenance which, I shall

tell you, that I have sometimes purposely made distillations, in which one part of the matter being, after the operation ended, put to the other, there will insue a sudden and manifest conflict between them, and sometimes an intense degree of heat. And that mineral exhalations, though otherwise not wholesome, may disable pestiferous effluvia, may be gathered from what I lately noted about a country, which abounding with veins of cinnabar, was, probably by their expirations, preserved from the pestilence. And our hypothesis will perhaps appear somewhat the more probable, if we reflect on what I lately mentioned of the sudden check, that is almost every summer given to the plague, which at that time is wont to reign at *Grand Cairo*. For since it is generally observed and complained of, that morbid causes do their work much more effectually than sanative ones; it seems very probable, that exhalations ascending from under-ground into the atmosphere may be capable of producing pestilential fevers, and the plague itself, since those corpuscles, that impregnate the Egyptian air upon the swelling of the Nile, are able to put a speedy stop, not only to the contagiousness but to the malignity of the plague, even when it is assisted by the summer heat, which at *Grand Cairo* is wont to be excessive.

BUT having insisted perhaps too long on this Egyptian pestilence, I shall only add, by way of illustration of the conjecture, that invited me to mention it, that the accession even of expirations, that are not themselves wholesome, may sometimes serve to correct the air, and put a sudden check to an epidemical disease; for corpuscles of differing kinds may by their coalitions acquire new qualities, and each sort of them lose some of those they had before: as, suppose there wandered in the air a great many effluvia, which by their determinate shape and bulk were apt to corrode or irritate the lungs, or the membranes of the brain, &c. as those of nitre are to corrode silver; it may happen, that another sort of reeks, though in their own nature unwholesome, may, by associating themselves with the first sort, and composing with them corpuscles of new qualities, abolish or much weaken the noxious ones they had before, in reference to this or that part of the human body. Though the spirits of salt-petre will readily corrode silver; yet if you add to them (as for some purposes I am wont to do) about half as much, or less, of the spirituous particles of common salt, (which yet are corrosive enough, and will fret asunder the parts of iron, copper, antimony, &c.) there will emerge a body, that will not at all corrode pure silver.

PROPOSITION IV.

It is very probable, that most of the diseases, that even physicians call new ones, are caused either chiefly or concurrently by subterranean steams.

THE product of my first endeavours to bring credit to the foregoing proposition appearing to have miscarried, when I came to send to the press the things I had written about it; that at least what can be preserved of it may not be lost, I shall substitute instead of it the following account.

AT the entrance of my discourse I observed, that the term *new disease* was much abused by the vulgar, who are wont to give that title to almost every fever, that, in autumn especially, varies a little in its symptoms, or other circumstances, from the fevers of the foregoing year or season. And therefore I declared, that by new diseases I meant only such, whose symptoms were so uncommon, that physicians themselves judged them to deserve that appellation: such, for instance, as the sudor Anglicus, or sweating sickness; that disease, which the learned *Wierus* and others call in Dutch *Die Varen*; an unheard of disease described by *Ronseius*, that in the year 1581 invaded

and destroyed many in the dukedom of *Lunenburg*; to which many physicians add the rickets, and others generally the *lues venerea*. Having cleared the terms, I next consider, whether there were really any new diseases properly so called, and gave some reasons to suspect, that some diseases, which among physicians themselves have passed for new, were extant before in *rerum natura*, though not in the country, wherein even the learned judged them to be new. And I intimated, that to examine this suspicion thoroughly, it is not safe to acquiesce in the books of physicians only; but it is fit to consult the writings of geographers, whether ancient (among whom I particularly recommended *Strabo*) or modern, together with the relations of historians, navigators, and other travellers. And here I enquired, without determining any thing, whether the *lues venerea* be, as most physicians are wont to suppose, a disease wholly new, or only new to our European world, and brought hither from some African, or other remote region, where it may be probably suspected to have long been endemical.

BUT taking it for granted, with the generality of physicians, that some new diseases are to be admitted; I advanced to consider some of the causes, to which they may be imputed, and to give some reasons, why I do not acquiesce in their opinion, though very general, that derive them only or chiefly from the varying influences of the heavenly bodies: for the most powerful of those, namely the sun and moon, act in too general and indeterminate a way, to afford a sufficient account of this affair; and as for the other lights, the fixt stars, besides their being universal and indefinite agents, their scarce measurable remoteness makes it justly questionable, whether they have any sensible operation upon any part of our bodies, save our eyes. And, though I deny not, that great intemperateness of the air, as to the four first qualities, as heat, cold, dryness, and moisture, are wont (not over justly) to be called, may dispose men's bodies to several great distempers, and may also be concurrent causes of those we are speaking of; yet neither can I acquiesce in these, when I consider, how much more frequently they happen, than new diseases do; and that their action, though various, is too general and indeterminate to persuade me, that they can be the adequate causes of effects so rare and anomalous, as diseases odd enough to deserve the title of new.

BUT now, the subterranean region of our globe, besides that it is always near us, abounds with variety of noxious minerals, and probably conceals great quantities of differing sorts of them, that are yet unknown to us; and since we have elsewhere proved, that there want not causes in the bowels of the earth to make great and irregular, and sometimes sudden confluxes, conflicts, dissipations, and other considerable changes, amongst the materials, that nature has plentifully treasured up in those her secret magazines; and since, in making out the three former propositions, we have manifested, that the subterranean parts of the globe we inhabit, may plentifully send up noxious effluvia of several kinds into the air: it ought not to seem improbable, that among this emergent variety of exotick and hurtful steams, some may be found capable to disaffect human bodies, after a very uncommon way, and thereby to produce new diseases, whose duration may be greater or smaller, according to the lastingness of those subterranean causes, that produce them. On which account it need be no wonder, that some new diseases have but a short duration, and vanish not long after their appearing, the source or fumes of the morbidic effluvia being soon destroyed or spent; whereas some others may continue longer upon the stage, as having under ground more settled and durable causes to maintain them: which last part of the observation may be illustrated by what happened in *Calabria*; which province, though it have been observed to have acquired, within these two or three ages, the faculty of

A discourse of subterranean steams as they affect the air.

producing manna upon certain trees*; yet this great change, though sudden enough, had it seems such stable causes, as well as of great extent, that it hath lasted several scores of years, and continues in that country to this day.

I AM not ignorant, that the whole doctrine propounded in the four propositions about the insalubrity of the air, is not at all comfortable either to patients or physicians: but important theories deserve to be enquired into, and, if true, to be delivered, though we could wish they were untrue. And judicious men rather thank than blame those, that have given us accounts of latent or unsuspected, though perhaps irremediable causes of diseases and of deaths; or have recorded the histories of some poisons, whereof the true antidotes are yet unknown. Uncommon notions about diseases may serve to enlarge the physician's mind and excite his attention and curiosity: and, besides that they may keep him from too obstinately persisting in the use of received medicines, though unsuccessful, upon a supposition, that the disease can have no other causes, than those wont to be assigned it by Classic authors; besides this, I say, I do not despair, but that either the sagacity or fortune of this inquisitive age, or at least of posterity, may by the blessing of God be happy enough to find proper remedies, even for those diseases, that proceed from subterranean effluvia, when once by proper signs they shall be distinctly observed; of which power of appropriated remedies I have known some instances, as to the very bad symptoms produced by antimonial and some other mineral fumes.

SOME of the points discoursed of, under the fourth proposition, were of affinity enough to paradoxes, to have need of being illustrated or confirmed by observations and experiments. And therefore having accidentally retrieved some of this last-named sort, I shall venture to subjoin them as a specimen, though without transitions or applications, but just as I found them thrown together in one loose sheet, wherein I lighted on them. But it is time to conclude with the recital of the promised experiments; which I would immediately do, but that I hold it fit to premise, by way of introduction to them, that I hope the things hitherto discoursed will appear much the more probable, if we shall prove, by experiments, that, which seems much less likely, than any thing we have above delivered; namely, that metals completely formed and malleable may be elevated into the air, and that perhaps without any great violence of fire, in the form of exhalations and vapours; the singly invisible corpuscles, still retaining their metalline nature. This, at least, as to some metals, I have endeavoured to prove in another tract, intitled, *A Paradox about the Fuel of Flames*. But because that discourse was never published, I will here set down two or three experiments, (not mentioned, that I remember in it;) which I do the more willingly, because it may be a thing of no small moment in physick, if it be shewn, that fixed and solid bodies, such as metals are, may by art be reduced into such minute corpuscles, that, without losing their nature and all their properties they may become parts of fumes, or perhaps of invisible vapours, or even of flame itself.

Particulars belonging to the fourth Proposition.

EXPERIMENT I.

WE took three parts or pounds of Dantzic vitriol (which is blue, and somewhat partakes of copper) and two parts or pounds of good sea-salt; these being very well powdered and mixed, were distilled with a strong naked fire, to force out all, that could

* C. Magnenus de manna, cap. 9. Dic amabo, Altomari, cur ante trecentos annos nullum manna fuit in Oenotria; jam certe aderant pagi ibidem urbisque vicinæ neque, fefellerisset curiosam incolarum solertiam, & c. 15. ante 240. annos nullum Manna Calabrensis in autoribus vestigium est.

could be driven over; and by this means we not only obtained a spirit of salt of a manifestly blueish colour, but there ascended also a considerable quantity of powder, which, being shaken with the liquor, settled at the bottom of it in the form of a powder, which was judged to consist of corpuscles of a cupreous nature, and perhaps also some of a martial nature. But I unhappily neglected the opportunity of examining this powder, which came up in quantity enough to have served for various trials.

EXPERIMENT II.

By substituting English vitriol (which is green, and is much more abundant in iron than that of Dantzic) and proceeding in other respects as in the former process, we obtained a very yellow spirit, with a considerable quantity of a yellowish powder, that was guessed to be a kind of *crocus martis*.

EXPERIMENT III.

WE took very thin plates of copper, and cast them into a retort, upon an equal or a double weight (for we did not always use the same) of good mercury sublimate; and luting on the receiver, gave a fire by degrees for several hours; by which means we usually obtained some running mercury, (which seemed to be very well putrified, and was perhaps also impregnated) together with some sublimate, that had not fastened upon the copper. And at the bottom of the retort we had good store of a ponderous and brittle substance, that did not look at all like a metal, but rather like something of a gummos or resinous nature, being also fusible and inflammable almost like sealing-wax. This, having not opportunity to prosecute the experiment at home, I put into the hands of an industrious physician, that was earnest with me to impart to him the process, and let him pursue it for me. He, according to my directions, exposed this metalline rosin, (if I may so call it) grossly beaten, to the free air, where it did, according to expectation, in a short time, change colour, and turn to a kind of verdegrease, which being dissolved in good spirit of salt, gave a solution of a very lovely green colour. This being slowly distilled *ad siccitatem*, yielded but a very weak and phlegmatic liquor; and the *caput mortuum* was again dissolved in fresh spirit, and the menstruum abstracted as before. This was done several times, till the matter was so impregnated, that the menstruum, being drawn off from it, came over as strong almost as when it was put on. This done, the thus impregnated verdegrease was diligently mingled with Tripoly, or some such insipid and fixed additament, and distilled with a strong fire; by which means it afforded good store of a liquor colourless, like common water; which made the physician suppose the experiment had miscarried, till I having dropped into it a colourless liquor, namely spirit of hartshorn or of sal-armoniac, he was much and delightfully surprized to find it presently disclose a deep and lovely blue colour. What afterwards became of this odd spirit, I need not here declare; what has been said being sufficient to shew, that corpuscles of copper may be elevated in the form of exhalations, both transparent and colourless. The next following experiment, though in part mentioned by some chymist, is here subjoined, because it is necessary, and applied to a particular purpose.

EXPERIMENT IV.

IF from good Cornish tin, you warily distil an equal or double weight of Venetian sublimate, into a very large receiver, very well luted on to the retort, you will obtain a spirituous liquor, which, as soon as the free air comes to touch it, will send up
abun-

abundance of white exhalations, in the form of a thick smoke, which will continue to be emitted much longer than one would imagine. But that, which I desire to have particularly observed in this experiment is, that though this liquor be apt to emit smoke, not only plentifully, but, as one would think, with violence, yet I found by trial, that even when I put it into a vessel, not streight mouthed, if I did but lay a piece of a single leaf of paper flatwise upon the orifice of the glass, so as to cover it all, the visible production of the fumes would presently cease; and the liquor would lie like common water, as long as the paper lay, though but lightly, upon the glass; though upon the removal of that, the liquor would send up plentiful fumes as before: which seems to argue, that some metalline substances may, by the contact of the air, have their copious ascension into the atmosphere very much helped and promoted, as if the air had saline, or other sort of particles in it, that are, in reference to some mineral bodies, of a very volatizing nature. The way, by which I have divers time elevated the fixedest of metals, gold itself, I have delivered in another paper, and shall not here repeat it. But I shall now set down an experiment, that, when it is carefully made, is easy to be performed, and yet affords a notable and sensible proof, that the corpuscles of a metal may be made to ascend, and that plentifully, even with a very moderate heat, under the form of ordinary fumes or smoke. To effect this I devised the following experiment.

WE took copper, and dissolved it in good aqua fortis, till the menstruum was* satiated with it; in the strong solution we steeped a while some brown, or other porous paper, that being fitter than the finer to soak up the menstruum; then slowly evaporating the superfluous moisture, we put a quantity of this imperfectly dried paper upon the hearth, at such a distance from a fire of actually flaming wood, that the paper was not kindled, but yet was so scorched, as to afford very plentiful fumes: these looked like ordinary smoke, whilst they moved through the air, and would questionless have mingled with it, and been dispersed through it, if the body, that emitted them, had not been purposely placed for a future design. But when the motion of the air towards the flame had carried these fumes to it, the metalline smoke did, as I expected, disclose its nature; for being actually kindled, it tinged the flame of a lovely colour, for the most part blue, and sometimes green, as it happened to be variously mixed with the flame and smoke of the wood.

A N
HISTORICAL ACCOUNT
OF A
Strangely self-moving LIQUOR.

Printed first in the PHILOSOPHICAL TRANSACTIONS, N^o CLXXVI. p. 1188.
Anno 1685.

AN ingenious teacher of mathematicks, having occasion to make a composition for a new fire-engine, whereof he was to shew his majesty a trial, mingled divers ingredients in an earthen pot over kindled coals; but could not, or did not do it so warily, but that the matter took fire, and began to blaze furiously, which obliged him to stifle the flame as hastily as he could; and having removed the vessel from the fire, and suffered it to grow cold, when afterwards he came to look upon it, to see if what remained might be of any use to him, he was surprized to find, it variously and briskly moved. Wherefore having set it aside, to be sure that it might be thoroughly cold, he, after some hours, visited it again, and found it move as before: and having cast store of seeds upon it, to see if the liquor would move them also, the bituminous part of it connected them into a kind of thick scum, that covered most of the superficies; but yet left some intervals, in which the liquor appeared, and discovered, that it continued its motions. Two days after, the engineer discoursing with me of his fire-work, about which he had advised with me before, told me, among other things, of this odd accident. And when I had asked him, if the motion continued still, and had been answered affirmatively, though it was then a dark night and ill weather, my diffidence, or my curiosity, made me engage him to send for the pot as it was; partly to be sure of the matter of fact, and partly to try, if the knowledge I had of the ingredients, which he had before told me, would afford any hint of the cause of so odd an effect; a like to which in kind, though not in degree, I had many years before devised, and successfully practised, the way of producing.

THE vessel being come, though the hasty transportation of it seemed to have sufficiently disturbed it, there did appear manifest signs of such a motion, as the engineer had ascribed to it; and therefore he being willing to leave it with me, I caused it to be set aside in a laboratory, where some furnaces kept the air constantly warm, and did there and elsewhere, at distant times, look heedfully upon it, now and then displacing, or quite taking off, some of the thick scum, that too much covered the surface of it; and by this means I had the opportunity to take notice of several phænomena, whereof these are the chief.

FIRST, I observed, that the motion of this liquor was not only brisk, but very various; so that having loosened some small portions of the scum from the rest, one of them would be carried towards the right hand for instance, and another towards the left, at the same time.—2. Where the liquor first came out from under the scum, it seemed to move the most briskly, flowing almost like a stream, whose motion upwards had been checked, and, as it were, reverberated, by that incumbent obstacle.—3. Several motions in this liquor were the more easy to be observed; because, though it were dark, yet it was not uniform; consisting in part of oily and bituminous ingredients, which, though they seemed to have but one common superficies with the rest of the liquor, yet, by their colours and power of vigorously reflecting the light, they were easily enough distinguishable from the rest. And I often observed, that some of these unctuous portions of the matter, emerging to the surface of the liquor, though perhaps at first one of them would not appear bigger than a pin's head, yet, in moving forwards, it would,

would, at the same time, diffuse itself circularly, and make, as it were, a great halo, adorned with the colours of the rainbow, and so very vivid, as afforded a very pleasant, and at first surprizing spectacle; these phantasms often nimbly succeeding one another, and lasting, till they lost themselves against or under the thick scum.—4. The motions of this odd liquor were not only various, but frequently vortical; to be satisfied of which I sometimes put short bits of straw, or fragments of some such like stuff, upon the discovered part of the surface of the liquor, by which they were carried towards very distant, if not opposite, parts of the vessel at the same time. But to make the vortical motion more evident, I several times detached considerably large pieces of the thick scum from the rest of the body; and had the pleasure to see them move both with a progressive motion in crooked lines, and with a motion about their own middlemost parts. All this while the liquor, whose parts were thus briskly moved, was actually cold, as to sense.—5. To observe what the presence, or absence, of the free air would do to this liquor, I caused many spoonfuls of it, with some of the scum, to be put into a cylindrical glass, which, though large itself, had a neck belonging to it, that was but about the bigness of one's thumb, that it might be well stopped with a cork. But having by this means, kept the free air from having a full and immediate contact with the whole surface of the mixture, as it had, when that mixture lay in the wide-mouthed vessel, I could not perceive the liquor to move to and fro, no not though the orifice of the neck were left open: whereas having, at the same time, poured some of the liquor into a very shallow and wide-mouthed vessel, called in the shops a clear caked glass, it moved rather more than less nimbly and variously than in the great earthen pot, (which yet was of the same shape) and shewed us many of those vivid and self-dilating circles, that have been mentioned in the third number. And these, by the fineness of their colours, and the quickness, wherewith they succeeded one another, afforded a delightful spectacle, as long as I stayed to observe the liquor.—6. Though the motions of the hitherto mentioned liquor did not seem to be always equally brisk, yet they appeared to continue manifest and various in some diversities of weather, as to cold and heat; and when I looked on it by candle-light, as well as by day-light. And, when being not well enough to visit it myself, I sent one purposely to look upon it, about ten o'clock at night, he brought me word, that it continued to move as formerly, and so it has done for ten days. And how much longer it will continue to do so, time must determine.

P O S T S C R I P T,

SOME time after the foregoing account had been written, when I came to look upon the liquor (which in the mean time had been several times viewed, and appeared to retain its motions) I found, to my trouble, that some body's impertinent curiosity and heedlessness had cracked the lower part of the earthen pot; at which overture the liquor, though not the scum, was run out; which had put a period to our observations, but that foreseeing, that such an accident might happen, I had long before taken out some spoonfuls of the liquor, and kept it close stopped in a vial. By this means I had the opportunity to observe, that when I poured out the liquor into a wide mouthed vessel, it would move as before, though this were done some weeks after it had been put up. And I remember, that long after having one day received the honour of a visit from a foreign minister, who was an inquisitive person, and a man of letters, we chanced, among other things, to talk of this liquor: and though it were scarce to be hoped, that it could still retain any of its motive virtue, yet, to gratify his curiosity, and that of some ingenious men there present, I caused the vial to be brought, and having unstopped it, I poured out the liquor into a convenient

shaped

shaped vessel ; in which, after we had suffered it to rest a while, they were delightfully surprized to see it move, (though not, in my opinion, quite so briskly as before, yet) very manifestly and variously. This encouraged me to think it possible, that it might retain some motion, though but languid, seven or eight weeks after ; and therefore on the 25th of *July*, I looked upon it again, and having caused it to be poured into a China cup, it manifested, at first, a brisk and various motion : but this, after a while, did so slacken, that I began to have some suspicion, that the motion it was put into by effusion, and the first contact of the air, might have given it the greatest part of its agitation. But this being but suspicion, I put the vessel into divers postures in a window, the better to discover the true cause of this phænomenon ; but whilst I was busy about this, which ingrossed my attention, a mischance overturned the cup, and by throwing down the liquor, put an end to my speculation : yet this mischance hindered me but from observing, how long the odd agitation of our liquor would have continued, but not from finding, that it lasted a great while ; for I shewed it the foreign minister about or after the beginning of *June*, that is, about five months, or more, after the liquor was first observed to move.

OF THE
Reconcileableness of SPECIFIC MEDICINES
TO THE
CORPUSCULAR PHILOSOPHY.

To which is annexed,

A Discourse about the Advantages of the Use of SIMPLE MEDICINES.

The P R E F A C E.

THE rise of the following tract, intimated near the beginning of it, was not such a fictitious thing as the reader may imagine: but though I really received a visit from a physician, known to me but by his reputation, purposely to propose to me his objections against the corpuscular philosophy, and he had a long conference with me about them; yet, because the historical passages of that interview cannot be circumstantially related in few words, I suppose the reader will willingly allow me to employ this preface, in giving him advertisements about the scope and design of the treatise it ushers in.

I SHALL therefore advertise him, that he will be much mistaken, if he shall expect, as I perceive several have done already, to find in this book a collection of receipts of specific remedies: for a moderate attention to the title page will enable him manifestly to discern, that the following paper, in its own nature, and in the direct and immediate design of it, is a speculative discourse; since it tends but to shew, that, in case there be specific medicines (as it is probable there are some) their experienced virtues are reconcileable to the principles of the corpuscular, or (as many call it) the new philosophy; and, at least, do not subvert them, if these effects and operations be not clearly explicable by them. And as this is the avowed scope of the following essay, so I chose to treat of it less like a physician than a naturalist; for physicks being a science, whose large extent invites and warrants its cultivators to search into the nature and phaenomena of things corporeal indefinitely, it must often happen, that the medicinal art, and this science, will be conversant about the same subject, though in differing ways, and with differing scopes; for there are divers hurtful or advantageous accidents and changes of the human body, whereof the naturalist takes notice, but as they are phaenomena, or changes produced by natural causes in the body of an animal, whilst the physician considers them as symptoms of diseases, or effects of medicines: the former directing his speculations to the discovery of truth, and the other his theory to the recovery of health. But because I elsewhere particularly consider the cognation and distinction between the discipline, that the naturalist, and that, which the physician cultivates, I shall forbear to mention them in this place; but rather acknowledge, that I scarce doubt, but that I might have enriched the following discourse with some choice particulars, if I would have perused and borrowed from the learned writings of the famous Dr. *Willis*: but besides that I had not his books at hand, I was unwilling to be prepossessed or byassed by his notions; and I presumed the person I wrote to would not be unwilling to see, what, without their help, the consideration of

the thing I treated of suggested to me. About this I shall now proceed to observe, that though the direct scope of the following discourse being to explicate the phenomena of some bodies, which, from their use, are called medicinal, and declare how possibly they may produce the effects ascribed to them, the ensuing discourse is for the main of a speculative nature; yet the consequences, that may be drawn from it, and the applications, that in this industrious age, are like to be made of some things, that it contains, may probably render it practical. For I have more than once observed, that divers considerable remedies, and some not unpromising methods too, have either remained unthought of, both by many Galenical physicians, and divers of their modern antagonists too; or, if proposed by others, have been rejected or slighted, barely upon this supposition, that no rational account can be given of their way of working, or how they should do good; and it is said to be unworthy of a rational physician to make use of a remedy, of whose manner of operating he cannot give a reason. How prejudicial it may be to many patients, that physicians be prepossessed with a bad opinion of an useful remedy, may be guessed by him, that shall consider, what multitudes of teeming women, that probably might have been saved by the skilful use of phlebotomy, have been suffered to die for want of it, upon a dislike of that remedy, that physicians for many ages thought to be grounded upon no less authority than a positive aphorism of *Hippocrates*. And therefore, if, to remove the specious objection newly mentioned against that whole kind of remedies called specifics, the following tract has been so happy as to shew, that it is at least possible, that medicines, said to be specific, may perform their operations by ways, which, though not explicable by the vulgar doctrine of the schools, are intelligible, and reconcileable to the clear principles of the mechanical philosophy: if, I say, this has been done by the theory proposed in this treatise, it may conduce somewhat to enlarge the minds of many physicians, and invite them to make use of several remedies, of which they did not think, or against which they were prejudiced. And since specifics, where they can be had, are wont to be free from any immoderate manifest quality, and for the most part to work more benignly, as well as more effectually, *ceteris paribus*, than other medicines; I think that to bring them into due request, and invite physicians to search for new ones, as well as employ those already known, may tend much to shorten many cures, and make them more easy and more safe.

Est aliquid prodire tenus, si non datur, ultra.

The ADVERTISEMENT of the PUBLISHER.

THE author had occasion to touch upon some of the same subjects, that he here treats of, in a book, *The usefulness of Experimental Philosophy*, long since published; but he had the misfortune to be reduced to write the following discourse about the specific medicines, and the utility of simple remedies, in a village, where he had not that book at hand, and could not call to mind all, that he had therein published seventeen or eighteen years before: on which account, though he studiously forbore to repeat the particulars, that he remembered to have set down in that treatise, how apposite soever they would have been to his present purpose, yet having, since the following discourse was sent to the press, got a sight of that other (which he had not read in many years) he finds, upon a transient view, that some of the same things are mentioned in both books; at which discovery, though he be somewhat troubled, yet he is the less so, because they are but few, in comparison of the new ones, and set down on such occasions, or with such other circumstances, that may make a favourable

able reader look on them, as not bare repetitions. And though in the forecited treatise, some of the motives to make use of simple medicines, be lightly touched; yet besides that they are not all, that are mentioned in the following invitation, those arguments, that are there but pointed at, are here treated of, and both confirmed, and explained by other observations and receipts. And since the printed book above mentioned has been for divers years very scarce, it is presumed, that those many readers, that have it not, will not be displeased to find here some few things, for which they cannot resort thither: and as the author foresaw he might be obliged to consent to the translation of the following papers into the Roman tongue, so he thought his Latin readers would not repine, though a great number of particulars had been borrowed of a book, that is not yet extant in their language.

I SHALL give you no farther account of the particulars contained in the two ensuing treatises, since the title pages give a sufficient hint of the noble author's main scope and chief design. I shall only say, that the first treatise effectually performs what has not been as yet attempted, by answering a very considerable objection against the doctrine of the corpuscularian philosophers; namely, that, which is taken from what we call specific medicines, their virtues and operations being hitherto judged by several of the learnedest sort wholly irreconcilable to the principles of the new philosophy; whereby he gratifieth, not only the curiosity of speculative philosophers, but does likewise a notable piece of service to all physicians, ushering in here and there such notions, as may be the principles of a sure and easy practice; yea, and enable them too, to give a good account of their own receipts; I mean of those, that contain specific medicines, whose virtues hitherto we could not describe to our patients, but by saying they did work we knew not how, or by some specific, that is by some occult or hidden quality. The second treatise, which is an invitation to the use of simple medicines, is of such a general use, that mankind is much indebted to this noble author for it: it is so well grounded both upon reason and experience, that this, as well as the forementioned discourse, does fully answer the great repute of the author, both at home and abroad, where he is commonly stiled *the English philosopher*.

OF THE
Reconcilableness of SPECIFIC MEDICINES
TO THE
CORPUSCULAR PHILOSOPHY.

The INTRODUCTION.

To my learned Friend Dr. F.

S I R,

PERceiving by our late conference, that the thing, which most alienates you from the corpuscular philosophy, is an objection drawn from your own profession and experience; namely, that the specific virtues of medicines are not reconcilable to it; my unwillingness, that an hypothesis I am so kind to, as I am to the mechanical, should continue under the disfavour of a person I so much esteem, as I do Dr. F. makes me venture to offer you the annexed paper, though it be but an enlargement of

of a dismembered part of what I long since, to gratify a friend, noted about the origin or production of occult qualities. For though I pretend not, that this trifle should satisfy a man of your judgment and learning, yet it may perhaps serve to keep you from thinking it impossible, that a skilful pen may be able quite to surmount those difficulties, that so bad a pen as mine is capable of lessening.

A paper belonging to the writings about the mechanical origin of qualities.

AMONG the several kinds of occult qualities, that, which is afforded by the specific virtues of medicines, is not here to be pretermitted: for these qualities do not only, like other hidden ones, invite our curiosity, but concern our health, and may hereafter (if I mistake not) appear to be of much greater importance, than as yet they are commonly thought. However, it may be worth while to take some notice of them in this place, if it were but because divers learned physicians do, as some of them owned to me, reject or disavour the corpuscular philosophy upon this account, that they think it cannot be reconciled to the virtues of specific remedies, or at least cannot, either in a particular, or in a general way, give any tolerable account of them.

I FIND three sorts of qualities mentioned in the books of physicians, under the notion of specific virtues; for by some a medicine is said to have a specific faculty, because it is eminently, and peculiarly friendly to this or that particular part of the body, as the heart, the brain, the eye, &c. by others it is said, by a specific power, to attract and evacuate some determinate humour, as choler, phlegm, &c. But the most usual account, upon which a medicine is said to be specific, is, that it has the virtue to cure, by some hidden property, this or that particular disease, as a pleurisy, an asthma, the cholick, the dropsy, &c. And this being the principal and most common sense, in which the word specific is employed by physicians, I shall ordinarily make use of it in that sense, in the following discourse, but yet without so confining myself to it, as not to consider it in the two other senses, when occasion shall require.

BUT before I descend to particular considerations, it will not be amiss to obviate mistakes, by declaring in what sense, in this paper, I shall employ the term specific medicine, especially in the last of the three aforementioned acceptations.

I do not then by a specific understand a medicine, that will cure the disease it is good for infallibly, and in all persons, that take it; for I confess I never yet met with any such remedy; nor do I by specific understand a medicine, that, almost like a charm, works only by some latent and unaccountable property, without the assistance of any known quality, as purgative, diuretic, sudorific, &c. to be found in other medicines: but by specific I mean in this discourse, such a medicine, as very often, if not most commonly, does very considerably, and better than ordinary medicines, relieve the patient, whether by quite curing, or much lessening his disease, and which acts principally upon the account of some property of peculiar virtue; so that if it have any manifest quality, that is friendly, yet the good it does is greater, than can be ascribed to the degree it has of that manifest quality, as hot, cold, bitter, sudorific, &c.

THERE are two grand questions, that may be proposed about the specific virtue ascribed to medicines: the first is, whether there be really any such? and the second, whether, if there be, the mechanical hypothesis can be accommodated to them.

THE former of these questions may admit of a double sense; for it may be proposed,

posed, with respect either to the present measure of our knowledge, or to those further attainments, that, in future times, men may arrive at.

IN the latter of these senses, (to dispatch first the consideration of that) I shall not presume to maintain, without restriction, either part of the question: for I do not only hope, but am apt to think, that in time the industry and sagacity of men will be able to discover intelligible causes of most of those qualities, that now pass for occult, and among them of many of the specific virtues ascribed to medicines. And yet, on the other side, I much fear, that men will not be successful in tracing out the true and immediate causes of those good effects of some remedies, that depend upon such fine and uncommon textures, and such latent and oddly guided motions, as fall not under our senses, though perhaps assisted by instruments: which conjecture will appear the less improbable, if we consider those admirable *idiosyncrasie*, or peculiarities of disposition, whereof the books of eminent writers afford us many instances, to whose number I could, upon my own observation, add several, if I thought it needful. And though I am not ignorant, that some of these may be plausibly accounted for, as that of some men's aversion to cheese, or to cats; yet I do not think, that the like explications can be extended to some others, that might be named, if it were here pertinent to discuss that thoroughly.

As to the former sense of the question lately propounded, I confess myself very inclinable to the affirmative, as far as I can judge by those writings of physicians I have had occasion to peruse: which limitation I add, because I would not derogate from the knowledge of particular persons, who, in so learned and inquisitive an age, may be arrived at far greater attainments, than those physicians have done, that have entertained the public about the occult and specific qualities of medicines.

I KNOW there have been, and still are, dogmatical physicians, that upon the principles, as they pretend, of the school-philosophy, reject all medicinal virtues, that they think not reducible to manifest qualities: but of such *Galen* somewhere justly complains, that they either deny matters of fact, or assign very incompetent causes of the effects they pretend to explain; and, for my part, I am so far from believing these men capable of giving sufficient reasons of the more hidden properties of medicines, that I am not apt to think them able, by their principles, to give clear and particular explications even of the more easy and familiar virtues of simples.

I AM therefore disposed to think, that, in the sense formerly delivered of the term specific medicines, there are some remedies, that deserve that name.

To this opinion I have been led by several reasons. And first, (to begin with the least weighty) it has the suffrage of many learned physicians, both ancient and modern, and particularly that of *Galen* himself, in several places of his works. And I remember, that treating of a specific remedy against the biting of a mad dog, which virtue he ascribes to an occult quality, or, as he speaks, to the propriety of the whole substance, he takes occasion to promise, that he would write a book of things, that operate upon that account: which book, if it had escaped with his other works (for he elsewhere cites it as having written it) would probably have furnished us with several things to strengthen our opinion. And though in matters philosophical I am little swayed by mere authority; yet the concurrent suffrage of many eminent physicians may, in this controversy, be the more considerable, because most of them, being noted practitioners, had opportunity to observe, whether or no any remedies deserved the name of specifics: and their testimony is, in our case, the more to be regarded, because physicians, especially famous ones, are not wont to be willing to acknowledge, that there are effects, which fall under the cognizance of their art, whereof they cannot give the causes.

*Galen. de
Simpl. Me-
dicam. Fac.
lib. 11.*

My next inducement to admit specifics, is founded upon parity of reason : for it is manifest, that there are divers formidable maladies, that are produced by considerable quantities of poisons, that have not been discovered to produce such great and dismal effects by any manifest quality, whether first, second, or third, as medical authors (I doubt not over accurately) distinguish them.

ON this occasion I shall add a very odd accident, about which I was advised with by an expert oculist, very soon after it happened : the case was this : a man lying somewhat long in bed in the morning, and chancing, as he lay upon his back, to cast up his eyes to the tester, saw a great spider, that stood still just over his face. Wherefore having reproached his wife, who happened to be in the room, with gross negligence, she took a broom, and struck it upon the upper part of the tester, to beat down the spider ; but the animal held so fast with his feet, that she missed her aim, and he, whether frightened or irritated by this rude shake, let fall upon the man, that was staring at it to see what would happen, a drop of liquor, that lighted directly upon one of his open eyes : but finding no heat nor sharpness ensue, but rather a very sensible coldness, he made nothing of it, but rose and put on his clothes : but presently after, happening to rub with his finger the other eye, he was sadly surprised to find himself suddenly benighted ; and calling for assistance, he found, that the eye, which the spider had let fall something on, though no change were noted in it by the by-standers, was totally deprived of sight. Upon which score he repaired to the above-mentioned oculist ; but whether he afterwards recovered his sight or no, I cannot tell ; all the endeavours the oculist and I employed to find out his lodging (to which it seems he had left a wrong direction) having been fruitless. This brought into my mind, that I had sometimes wondered to see, how much more quickly spiders will kill flies, than the cutting off their heads, or running them quite through with pins or needles will do.

BUT to return to what I was saying, of the great mischief done to human bodies by very small quantities of poison, methinks one may thence argue, that it seems not improbable, that appropriated medicines, especially when administered in greater quantity, may produce very notable changes in the human body to the advantage of it. But on this occasion I expect to be told, that it is much more easy to do harm than good, and I confess it is so in the general ; but yet, in the particular case before us, I consider that some poisons, that produce such dreadful symptoms in the body, are frequently cured by their appropriated antidotes, which therefore must have a salutative power great enough, with the help but of the ordinary concurrence of nature, to surmount the efficacy of the venomous matter. To which I shall add this more familiar instance, that as perfumes do often enough produce various, and sometimes frightful symptoms, in many hysterical women ; so the fumes of the burnt feathers of partridges, woodcocks, &c. do frequently cure the fit in as little time, as the sweet smell procured it. And I have often found the smell of strong spirit of harts-horn, or of sal-armoniac, recover such women in far less time, than the fragrant odours employed to make them sick.

THE third and principal inducement I had, to think there are specific remedies, is, from experience. I might urge, on this occasion, the testimony of *Galen*, who tells us more than once, that he himself therefore confided in the ashes of burnt craw-fishes, for the cure of the biting of a mad dog, because never any of those, that took it, died. And to annex that upon the bye, for the usefulness of it, he adds, that though the effect of these ashes be admirable, even when given alone, yet their virtue may be increased, by adding to ten parts of burnt craw-fishes five of gentian and one of frank-

*Galen. de
simpl. Med.
Fac. lib.*

incense.

incense. And the great virtue of these burnt shell-fishes I find to have been taken notice of some ages before *Galen*; *Dioscorides* much commending them against the same disease, that the *Pergamenian* does.

I SHALL in this place purposely forbear to mention such medicines, as though by diverse learned physicians commended as specifics, are yet by others much questioned, if not flatly denied to be so; since it may be more proper, and may perhaps suffice, to mention two or three, whose efficacy is more notorious.

It is known, by almost daily experience, in *Italy* and divers other hot countries, that though the stings of scorpions oftentimes produce very acute pains, and formidable symptoms, yet the mischief is easily remedied, either by presently crushing the body of the scorpion upon the hurt, or by anointing the part affected with oil of scorpions, (for that reason to be almost every where found,) which being made by suffocating those insects in common oil, and keeping it long in the sun, the liquor does not at all appear to have any manifest quality, to which its sanative efficacy may be ascribed.

THE bitings of those serpents, which, for the noise they are wont to make with a kind of empty bladders in their tails, the English call rattle-snakes, are counted much more poisonous and dangerous, than the stings of scorpions; of which I remember a learned eye-witness, that lived divers years in *Virginia*, where they much abound, related to me a very strange instance, which I cannot now stay to set down: and yet the English planters, when they have the misfortune to be bitten by these serpents, are wont to cure themselves very happily by the use of that plant, which from its effects, and the place it grows in, is well known by the name of *Virginia snake-weed*, [or *serpentaria Virginiana*.]

THAT the Peruvian bark, commonly called here in *England* the Jesuits powder, is a specific against agues, particularly quartans, divers learned physicians not only grant but assert; and I remember the justly famous Dr. *Willis* gave me this character of it in private discourse, (not without taking notice, that some decried it,) it is the noblest medicine we (meaning the physicians) know. But though I will not dispute, whether it be so certain and safe a specific for agues, as it is believed by divers eminent doctors; yet I think it can scarce be denied to be a specific medicine to stop the fits of agues, (in the notion of specific remedies formerly delivered) since it does that more effectually, than the generality of physicians, for many ages, were wont to do with their other antifebrile medicines.

I MIGHT here tell you, that I have myself seen a stone, whose efficacy in stopping hæmorrhages invited my wonder; and another, which performed extraordinary things in more than one distemper, though I could not perceive, that either of them did these things by any manifest quality. And I might here add some other particulars, that may be borrowed from experience, in favour of our opinion; but that it is like they will be more properly alledged hereafter, in some places of the remaining part of our discourse.

I KNOW those, that have rejected specific medicines, have confidently urged three plausible arguments against them. For some physicians deny there are any effects of medicines so considerable as to make them deserve the name of specific; others would probably allow, that experience favours our opinion, if they did not think the way of a specific medicine's operating must be inexplicable, and consequently ought not to be admitted by physicians; and others again (being of sentiments very differing from these) will allow them to be very efficacious, but endeavour to derive their whole efficacy

cacy from manifest qualities as heat, cold, tenuity of parts, faculty of making large evacuations by vomit, siege, &c.

BUT these objections will be more opportunely considered in due places; only there is one argument, that may be objected by the deniers of specific remedies, which I confess is so specious, as to deserve to be particularly examined in this place, lest it should, if unremoved, beget too strong a prejudice against a great part of the ensuing discourse. For it may be said, that a medicine taken in at the mouth must in the stomach and guts be at least very much changed by digestion and the aliments it meets with there, and a good part of it will be proscribed among excrements: that, after it has passed out of the stomach, it must meet with divers strainers of differing textures, which will probably stop all or most of the medicinal corpuscles, that would pervade them: and that if any shall be so lucky, or so penetrating, as to surmount all these obstacles, they will probably either be assimilated unto the substance of the body, or quite changed by the parts they will be fain to combine with there; or, if yet any should be able so obstinately to retain their pristine nature, they will in all likelihood be too few to have any considerable operation upon the body. But to this plausible objection I have several things to oppose by way of answer.

1. AND first I may represent, that divers specific medicines, as some ointments, plaisters, pultises, amulets, pericarpia, &c. being outwardly applied, their corpuscles can get into the mass of blood without passing through the stomach, and consequently are not concerned in the proposed objection.

2. AGAINST most of the Galenical physicians, that are wont to urge the formerly proposed objection, I see not, why one may not argue *ad hominem*, by putting them in mind, that the same difficulties for the main, or others not inferior, may be alledged against a common opinion of their own: for since they believe that purgatives, cordials, diaphoreticks, besides cephalicks, hepaticks, and some other sorts of medicines, do temperate and sweeten the blood, and usefully affect the newly mentioned stable parts; and since these medicines act not by naked qualities, but by small particles of their own substance, if they can give us an intelligible account of the ingress of these particles in considerable numbers into the recesses of the body, without being dispoiled of their particular virtues, they will at the same time instruct us, how to answer the objection they urge against us.

3. AND in regard the generality of physicians hold, that milk and urine were materially in the mass of blood, and are separated from it by the breasts and kidneys, I think one may by experience shew the invalidity of their ratiocination against specifics: for it is obvious to observe, and I have several times done it myself, that rhubarb will (perhaps for many hours) tinge the urine of those, that take any considerable dose of it. And in some of our English American colonies there grows a fruit, which the planters call the prickled pear, whose inward substance is exceeding red, and whose being pleasant in taste as well as colour frequently invites eaters; but its juice is of so penetrating a nature, that it passes from the stomach into the bladder, and then into the chamber-pot, with so little loss of its redness, that strangers are wont to be surprized and frightened at it, as thinking this unknown fruit had made them void bloody urine, if not blood rather than urine. This is a known thing among those, that have dwelt in our southern plantations, and has been affirmed to me by unsuspected eye-witnesses, and among them by a famous physician. As for milk, the great *Hippocrates* himself informs us, that if a woman, or a she-goat, take elaterium, the cathartic virtue passes into the milk, and will purge the child that drinks it; and I remember, that having occasion to make some stay in the spring or beginning of summer, in the confines of Switzerland and Savoy, I had the opportunity to observe this odd

phænomenon; that when the cows in that district fed, as they would in that season plentifully do, upon a certain weed, said to be a kind of wild garlick, that grew copiously in the pastures, the very butter made of their milk had so rank a taste of the herb, that though I was not, yet divers other strangers were, thereby diverted from eating of it, though otherwise fresh and good. And I remember too, that having passed a winter on the sea-coast of the county of *Cork* in *Ireland*, I found it a known observation, that a sort of greedy sea-fowl, whose name comes not now into my mind, living almost wholly upon fish (upon whose shoals I have sometimes wondered to see such a multitude of ravenous fowls attending) they acquire a taste, that makes some pleasantly question, whether the food they afford be to be reputed flesh or fish. But how constantly the particles of divers bodies may retain their nature in all the digestion and strainers they pass through, I have more amply discoursed in another tract, *About the concealments and disguises of seminal principles*; and I presume I have here said enough to allow me to proceed to the fourth part of my answer.

4. I CONSIDER then, in the last place, that whereas it is objected, that so small a quantity of the matter of a specific, as is able to retain its nature, when it arrives at the part it should work on, must have little or no power left to relieve it; this difficulty will not much stagger those, that know, how unsafe it is to measure the power, that natural agents may have to work upon such an engine as the human body, by their bulk, rather than by their subtilty and activity. A sober gentleman, that was governor of a colony in the torrid zone, and commanded a warlike English vessel, that sailed up very far in the great river of *Gambia* or *Gambra* in *Africk*, and staid there some time to trade with the Negroes of the inland country, being inquired of by me, among other things, about the poisons, that are said to be extraordinarily powerful in the parts he came from; he answered me, that the Blacks had a poison, that was, though somewhat slow, yet very mortal, in so small a dose, that it was usual for them to hide enough of it to kill a man under one of their nails, which they wear somewhat long; whence they would drop it so dextrously into the drink, or milk, or broth, or other liquid aliment of those they owe a spite to, that it is scarce possible for a stranger to be watchful enough to prevent it. For which reason, as he told me, though he sometimes eat with their petty princes or governors at the same table, yet he would never eat out of the same dish, nor drink out of the same cups with any of them. He added, that in another part of *Africa*, a famous knight, who commanded the English there, and lately died a ship-board in his way home, was so poisoned at a parting treat by a young Negroe woman of quality, whom he had enjoyed, and declined to take with him, according to his promise, into *Europe*. And though my relator early gave him notice of what he suspected to be the cause of this indisposition, and engaged him thereupon to take antidotes, and cordials, as treacle, &c. yet his languishing distemper still increased till it killed him.

I COULD name a vegetable substance growing in *Europe*, and perhaps not far from hence, which though some empiricks employ as a medicine, is so violently operative, that a learned and famous modern physician relates, that no more than half a grain would work so violently, as to cause very dangerous hypercatharses, of which though he remedied some, yet he was not able to keep all from being mortal. And because many ingenious men deny, that our English vipers are poisonous, I shall add in favour of the argument that I have been enforcing, that I know a young man, who having been bitten by an English viper, which he too rashly laid hold on, though the tooth pricked but his hand, yet the venom conveyed by so small a hurt, which perhaps equalled not in quantity the hundredth part of a pin's head, quickly produced in him the bad symptoms, that usually follow the biting of that serpent; and among others (for I particularly asked him about that) a violent vomiting of ill-conditioned stuff.

I know

I know also a person, that practised physick in the isle of *Java*, where scorpions are held to be more venomous than in *Italy*, who having, after he had drank somewhat freely, provoked, and been stung by, a scorpion, though the hurt was but in his thumb, and was so small, that I could not perceive the least scar it had left, that it put him presently to such violent tortures, for some hours, till he had procured specific remedies, that he looked upon himself a dead man; and felt so raging a heat within, that he thought (to use his own expression) that hell-fire was got into his body. Nor is it only by mere poisons, that a human body may be greatly affected, though the agent be but very inconsiderable for bulk and weight; for we see, that divers women, otherwise strong and healthy, will be cast into swooning fits, and perhaps will complain of suffocation, and be put into convulsive motions, by the fragrant odours of musk or civet; though if all the effluvia, that cause these symptoms, were reduced into one aggregate, this would not probably amount to a hundredth, nor perhaps to a thousandth part of a grain. And I have sometimes speedily suppressed such fits by the odour of the volatile salts, hartshorn, sal armoniac, or the like, or of distilled spirits abounding with such salts; though perhaps all the particles, that actually relieved the patient, and calmed these frightful symptoms, if packed together, would not have equalled, either in bigness or in weight, the tenth, not to say the fifteenth, or the hundredth part of a grain of mustard-seed. And as for inward remedies, it is vulgarly known, that in the infusion of crocus metallorum, the corpuscles, that render the liquor vehemently vomitive and purgative, are so very minute, that great proportions of wine, or other vehicles, may be strongly impregnated with them, without any sensible diminution of the body, that parts with them. And of this we have a not less, if not more, considerable instance, when quicksilver is decocted or long infused in common water. For *Helmont* observes, that though the liquor be not altered in colour or taste, nor the quicksilver at all sensibly changed, nay, nor grown any thing lighter in a balance; yet the liquor does, by means of these insensible and unponderable effluxes of the quicksilver, acquire a notable virtue against worms; for which purpose, not only *Helmont*, but before him that experienced chymist *Hartman*, and another eminent writer, extol this medicine. And, on this occasion, I remember, that a fine boy, born to be heir to a very illustrious family, falling into a dangerous fever, which was judged to proceed from worms or verminous matter; a famous and experienced physician, that treated him, confessed to me, that he was out of hopes of him; because the child having been bred to have his will, and tired with unsuccessful remedies, was so obstinate and careful in refusing to take any thing, that smelled or relished of a medicine, that he forbore, in spite of all the art used to deceive him, even to drink any thing but small beer. Whereupon I persuaded both the doctor, and the lord, whose son the child was, to impregnate his small beer with mercurial particles, by frequently shaking it with good quicksilver in it; by which means the patient perceiving no change of colour or taste in the drink, swallowed it greedily, and through the blessing of God was soon after restored to a health, which the parties concerned ascribed to the mercurial remedy.

I SHOULD condemn myself for having bestowed so many words upon one objection, but that I hope the answer given to it in this place will facilitate and shorten several things relating to my present subject, specific medicines; about which I shall now proceed to offer my thoughts in some propositions, and short discourses upon them.

HAVING now dispatched the first of the two formerly proposed enquiries, I proceed to the second; namely, whether the mechanical hypothesis can be accommodated to specific medicines, so as that they may be either intelligibly explicated by

it, or at least shewn to be reconcileable to it? I presume you will easily believe, that there are few writers more inclinable, than I am, to confess the dimness of our knowledge, and the obscurity of many things in nature: or that are more forward, than I, to grant, that many of the operations of specific medicines are to be reckoned among those abstruse things, whereof nature seems to affect the concealment: But notwithstanding this, when I consider, how comprehensive and fertile the principles of the corpuscular philosophy are, I cannot despair, but that it will be found, that divers of the effects of these medicines may be, in a general way, explicated by them, and not any will appear inconsistent with them. This I desire may be here taken notice of once for all, that, retaining the scope of the following discourse still in your memory, you may not think it strange, that I content myself, on most occasions, to give in general possible explications, and to shew, that specific medicines may operate on some such account as I propose, without affirming, that they certainly do so. I observed soon after the beginning of this paper, that there were three sorts of virtues, to which physicians (though not unanimously) have given this title of specific; namely, such as evacuate some particular humour, such as are peculiarly friendly to this or that part of the human body, and such as in an unknown way cure or much lessen this or that determinate disease. But yet I shall now apply my discourse peculiarly to the last sort of these medicines, as being both more considerable in itself, and the chief subject intended in the present discourse; giving nevertheless, as occasion serves, such additional hints and observations, as may make the reflections belonging to this third sort of specifics, easily applicable, *mutatis mutandis*, to the other two.

AND I shall begin with laying here for a foundation, what I have in another treatise had occasion to deliver and make out; namely, that a living human body is not to be looked upon as a mere statue, or a mere congeries of the materials it is composed of, flesh, blood, bones, fat, nerves, veins, arteries, &c. but an admirably framed engine, consisting of stable, liquid, and pneumatic substances, so exquisitely adapted to their respective functions and uses, that oftentimes the effects of an agent upon it are not to be measured so much by the power of that agent considered in itself, as by the effects, that are consequently produced by the action of the parts of the living engine itself upon one another.

THIS premised, I consider, that there is no need to grant, that the operations of all specifics, or of the same in differing diseases, must be of one kind; but that differing specifics may operate in several manners, and some by one of these ways may oppugn such a disease, and others may do good against such another. And of these general ways I shall briefly propose six or seven, that now occur to my thoughts; having first given you this important caution, that the specific remedy does not commonly (though sometimes it may) relieve the patient by this or that single way of operating, but by a concurrence of two or more, that, as it were, join their forces to produce the desired effect.

PROPOSITION I.

And first, sometimes the specific medicine may cure by discussing or resolving the morbid matter, and thereby making it fit for expulsion by the greater common shores of the body, and the pores of the skin.

IT is known that many diseases, and those oftentimes stubborn and chronical, proceed from certain tough or viscous humours, that obstruct the passages, whereby the blood should circulate, or other useful liquors be transmitted; and these peccant humours

mours are oftentimes so viscid and obstinate, that ordinary remedies will do little or no good upon them. And yet a specific may, by the smallness and congruous figure of some of its corpuscles, get through the pores into the recesses of this stubborn matter: and by their solidity, figure, and agitation, promoted by the heat of the patient's body, may dissolve and ruin the texture of the morbid matter, and render it capable of being proscribed by nature, by urine, sweat, or some other commodious and innocent evacuation. Thus the blood, or some other liquor of the body, being (to use the chymists phrase) impregnated with the friendly and operative particles of the remedy, becomes an appropriated menstruum in reference to the peccant matter; impregnated with sal armoniac, becomes a menstruum, that by degrees will dissolve both copper and iron, as compact bodies as they are. I said appropriated menstruum, because there is no sufficient reason to suppose, that the menstruum works by any manifest quality, as heat, moisture, &c. or even by acidity itself; but rather by virtue of the fitness, which the shape, bulk, solidity, and other mechanical affections of its particles, concur to give it, to disjoin the parts of a body of such a determinate texture. For, as I have in another paper amply shewn, there are far more menstrooms of distinct sorts, than are commonly taken notice of; and the operations of these cannot safely be measured by the strength of their manifest qualities, since it may several times happen, that a menstruum, less acid or less strongly tasted, may dissolve this or that body, which another menstruum, that seems far stronger, will not work on. Thus cold water will dissolve the white of an egg, which pure spirit of wine will be so far from dissolving, that it will coagulate it; [and so will spirit of salt and oil of vitriol itself.] Thus dephlegmed spirit of urine will readily dissolve minute filings of copper, which spirit of vinegar will but slowly work upon; and yet this liquor will speedily dissolve crabs eyes, which spirit of urine will leave entire. Thus quicksilver, that is insipid, will in the cold dissolve gold, which *aqua fortis* itself, though assisted by external heat, will not work upon; and yet *aqua fortis* will furiously beat asunder the parts of iron, though quicksilver will not so much as adhere to its surface. And thus in fine (not to accumulate instances) common oil, that is so smooth upon the tongue, and will not dissolve so much as an egg-shell, will dissolve brimstone, which yet will resist *aqua fortis* itself, that will dissolve almost all metals, beside many hard stones and minerals. And I know a liquor, having more than once prepared it, which, though so weak, that one may drink a wine glass full of it pure without danger, will yet work on some very hard bodies, both stones and metals, in a way that is not to be matched, among the highly corrosive menstrooms in use among chymists.

AND now supposing, that the active corpuscles of a specific medicine, associated with the blood or other vehicle they impregnate, may act upon the morbid matters they meet with in the body, after the manner of a menstruum; supposing this, I say, we may hence illustrate several things, that have reference to the operation of specific medicines.

1. AND we may hence derive a guess, why an appropriated medicine will perform things, which will not be done by another, whose manifest qualities seem to be the same for kind, and much stronger in degree. For menstrooms do not always act according to the degree of their acidity, or the like sensible quality; but according to the congruity of their corpuscles to the pores of the body they are to dissolve, and also oftentimes according to a fitness, that depends upon other mechanical affections of the acting liquor: and therefore physicians, as well as others, may easily mistake in their argumentations *à majori ad minus*, & *à minori ad majus*. For the consequence is not good to argue either thus; water, which is so strengthless a liquor, will dissolve gum Arabic; therefore highly rectified spirit of wine, which is a much more subtle

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and penetrating liquor, will do the same thing more powerfully : for experience shews it will not dissolve it at all : or thus, strong oil of vitriol is more corrosive in taste, and will dissolve many bodies, that *aqua fortis* will not ; therefore it will also dissolve silver as well as *aqua fortis*, the contrary of which is true. Nay it is not a good inference to argue thus ; *aqua fortis* dissolves silver by virtue of its acid spirits : therefore the more it abounds with these, the more potently it will dissolve that metal ; whereas I have elsewhere proved by experience, that if *aqua fortis* be made exceeding strong, it will not work upon silver ; but it will readily do it, if it be weakened by the addition of a fit quantity of common water.

To this I shall add, that the dissolution of a body may depend, as well upon the peculiar texture of the body itself, as the manifest strength of the menstruum.

2dly. THE foregoing doctrine may suggest a reason, why a medicine, that does wonders in one disease, may do little or nothing in another, that some may think to be a kin to it, and perhaps too, more easily superable by it ; for the presumed cognation may not be so great, but that some dissimilitude of texture in the morbid matter may make one of them unfit to be wrought upon by the same menstruum, that dissolves the other : and though pure spirit of wine will easily enough dissolve *gummi Guajacum*, and also the little portions of resinous matter, that are harboured in the pores and small cavities of the wood ; yet the same menstruum will not work upon the wood itself of the tree, that affords those soluble substances.

3. THIS may keep it from being thought strange, that specific medicines should sometimes fail of their usual effects. For as the bodies of individual patients may differ very much, either according to their natural constitution, or to that, which they acquire by the disease, that distempers them, or on both those accounts ; so it ought not to seem strange, that, in some sick persons among many, the congruity between the agent and patient should be altered, either by some considerable change in the texture of the morbid matter, or by some notable alteration, that the corpuscles of the medicine receive in their passage through the vessels, by the admixture of some incongruous particles of the blood, or other vehicle. Thus spirit of salt will, as I have tried, dissolve copper, as spirit of nitre does : which notwithstanding, though this last named liquor will dissolve silver, yet if you mix with it spirit of salt, which, by the like operation of both upon copper, seems to be amicable to it, the spirit of nitre will no more be able to dissolve silver as it could before.

4thly. OUR hypothesis may also hint to us an answer to one of the main and most plausible objections of the deniers of specific medicines. For some of them ask in a scornful way, how it is possible, that a medicine should rove up and down in the mass of blood, and, neglecting all other things, should single out and fasten upon the morbid matter men wish it should proscribe ? For if the medicine acts by impregnating the blood, or some other liquor of the body, and turning it into a kind of menstruum, it is very possible, both that the strainers, through which the corpuscles must pass, may keep back the inconvenient parts of the vehicle ; and (which is in our case more considerable) the menstruum may be either appropriated to the peccant humour, as has been formerly declared, or else may at least be qualified to resolve that more easily, than any other substance it meets with in the body. As if you take some bone-ashes, and *Crocus Martis*, and saw-dust, and powdered sea-salt, and filings of gold, and blend all these together : if upon one half of this mixture you pour common water, it will not meddle with any other of the ingredients except the sea-salt, which it will readily dissolve : and if upon the other half of the same mixture you put a sufficient quantity of quicksilver, and rub them together, this metalline liquor will neglect all the rest of the ingredients, and the sea-salt itself, and fasten upon the gold.

And those, that work in the Spanish gold-mines, inform us, that when they have well ground some ore, that contains gold and copper, besides heterogeneous minerals, well heated quicksilver, will take up the gold much sooner and better, than it will the copper, scarce meddling with the latter, as long as there remains any not despicable quantity of the former to be wrought upon by it. And as for the supposed difficulty, that the medicine should ferret out, if I may so speak, the morbid matter, in what vessel soever of the body it lies, this objection might have been considerable, before the discovery of the blood's circulation; but it is not so now, that we know, that things, that once get into the mass of blood, are presently whirled about with it, and may be conveyed by it even to small vessels lying in the remotest parts of the body.

5thly. AND this prompts me to take notice, that our hypothesis may help us to answer those many learned physicians, that either reject, or at least despise, most external remedies, especially pericarpia, amulets, and appensa, upon a supposition, both that they neither can furnish the body they do but externally touch with any store of medicinal particles; and, which is chiefly in this place to be considered, that being but external remedies, they must be very unable to do good in internal diseases, especially such as are seated in parts remote from those, which the medicine is applied to. But as to the former part of the objection, it will not be difficult to answer it to him, that has read what I have elsewhere written of the subtilty, numerousness, and efficacy of effluvia. And we need but consider, what plenty of particles, sensible to the nostrils, are for a long time emitted by a small quantity of ambergrease, or even of camphire (which is often externally used, and the multitude of magnetical corpuscles, that for many years constantly effluvia from a small vigorous loadstone, to think it possible, that even dry and stable bodies may afford sufficient store of effluvia to perform considerable things in so curiously framed an engine as the human body is; where we see, that the odour of musk or civet, for instance, may speedily cast divers persons into fits, and the smell of castor or *assa fœdita*, and much more that of salt of harts-horn, or of sal-armoniac, quickly relieve them. And as to the second part of the objection, what I have elsewhere made out, and the best modern physicians grant, of the porosity of the skin, shews, that it is very possible for the subtil effluvia of several bodies to get through the pores of the skin; and when they have once got admittance, so much as into the smaller vessels, it is easy to conceive, how these may carry them into the greater, and consequently into the mass of blood, by whose circulation they may be readily conveyed to all the parts of the body, and among them to the seat of the disease: and perhaps, (to add that upon the bye,) the efficacy of these corpuscles, that, if I may so speak, get in at the key-hole, not at the door, may be the more considerable, because they get presently into the mass of blood, without passing through those digestions in the stomach and other parts, which oftentimes much weaken the virtue of medicines taken in at the mouth before they arrive at the blood.

The Essay
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PROPOSITION II.

Sometimes a specific medicine may mortify the over acid or other immoderate particles, that infest the mass of blood, and destroy their coagulatory or other effects.

THOUGH I am not of their opinion, who of late are wont to impute almost all diseases to acidity abounding in the blood and other liquors of the body, by whose intervention the stable parts also are offended; yet I readily grant, that a considerable number of distempers are, at least in great part, produced either by acids themselves,
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or by their bad effects or productions. Agreeably to which doctrine we may very probably conceive, that several maladies may be either quite cured, or much lessened, by a specific remedy, that abounds in corpuscles fitted to mortify acids. This mortification may be effected by more than one way; and of these ways the chief, that now occur to my thoughts, are two.

FOR there are some bodies, that mortify or disable acids by a positive hostility, if I may so term it; that is, by such a contrariety, as is discernible by the taste, and more by the visible conflict and manifest tumult, that is produced, when they come to invade an acid. Of this sort of mortifiers of acids are the most part of those, that are called alcalifate salts; whether fixt, as the lixivial salts of plants, or volatile, as the spirits and ascending salts of urine, blood, hartshorn, foot, &c. as may be exemplified, when any of these comes to be mingled with *aqua fortis*, spirit of salt, oil of vitriol, or the like acid liquors, by which, by the way, we may see, that those Galenists mistake, who ascribe the virtues of spirit of hartshorn, and of urine, only to their tenuity of parts, briskness of motion, and the like affections, that they might not seem beholden to the chymists for so useful a notion, as that of the contrariety of acids and alcalies.

THE other principal way, by which acids may be mortified, or disabled to bite, is by sheathing them, if I may so express it, for as a knife may be disabled to cut, either by filing off or otherwise blunting its edge, or else by covering the blade with a sheath fit for it, or by sticking it into a loaf of bread, or the like body fit to receive and detain the whole blade; so an acid corpuscle may lose its power of cutting or pricking, either by having its figure spoiled by the action of a strong and manifest alkali, or else by being, as it were, sheathed in a porous body, though perhaps endowed with no taste or any other manifest quality, by which one would think it contrary to the acid it disables, as a file is to the edge of a knife. Of this way of mortifying acids, chymical operations afford us many instances; as when *menium* destroys the acidity of spirit of vinegar; as I have found chalk will do that of *aqua fortis* itself; and *lapis calaminaris* very much lessens, as well as alters, the acidity of spirit of salt, and even of spirit of nitre. And I the rather mention this mineral, both because its qualities are less known to physicians and the generality of chymists, and because it supplies me with an argument to prove, that acids may be, though I do not think they always are, rather sheathed in, than destroyed, by the bodies that silently mortify them; for, as *Glauber* has truly enough observed, acid spirits (as I have tried in some) may by force of fire be driven in distillation out of the *lapis calaminaris* very much dephlegmed, and stronger than before.

I KNOW it may be here objected, that the mortification of acids is performed by a manifest quality, and therefore makes nothing for the favourers of specific medicines; but to this I answer,

1. THAT the power of mortifying acids, especially by sheathing them, or, if you please, by absorption of them, is none of those qualities, whether first, second, or third, that the former physicians took notice of in medicines; though the sufficiency of these qualities to cure diseases, has been, and still is, used by many, as a ground of denying the specific virtues of remedies.

2. THAT I have often looked upon it as an unhappy mistake, and of ill consequence, that so many learned modern physicians take it for granted, that if a medicine be endowed with a manifest quality, as acid or alcalifate, the good it does, (and the like for the most part may be said of the harm) may safely be ascribed to that quality, that is, to its being of an acid, or else of an alcalifate nature; whereas, in my

poor judgment, there being a considerable disparity, as various trials have assured me, between acid and acid, as likewise between alcali and alcali, it is fit to distinguish betwixt an acid, for instance, as merely such, and the peculiar modification, that may belong to that acid. Thus, though all acid menstrooms, that I know of, if they be well dephlegmed, will dissolve copper; yet *aqua regis*, that will dissolve not only that metal, but the much more closely compacted body of gold, will not at all dissolve silver; as on the other side *aqua fortis*, as corrosive a menstruum as it is, will not of itself dissolve gold, but, if you give it a new modification, by adding to it common spirit of salt, which itself I have often found (whatever chymists think or have written to the contrary) will leave it entire, the *aqua fortis* will easily dissolve that metal. Nay, a different modification may not only make a disparity between acids, but that, which, according to the received way of judging, ought to be called a contrariety; for spirit of salt will precipitate silver, which *aqua fortis* has dissolved; and spirit of nitre, though one of the acideft menstrooms we have, will not only precipitate an antimonial powder out of that odd substance, that chymists call butter of antimony, but will do it with a wonderful conflict, tumult, and effervescence; and yet this butter of antimony is so highly acid, that a little quantity of it, put into a considerable one of water, makes it so four, that many chymists call it *acetum philosophorum*. And now, to apply these things to the lately proposed objection, I desire it may be remembered, that near the beginning of this letter I plainly intimated to you, that I did not deny, but that a specific medicine may sometimes be accompanied with, or even in part operate by a manifest quality; but that yet I thought the good effect was not due barely to the kind or degree of the manifest quality, but to somewhat superadded, which gave it a specific virtue against this or that particular disease. And suitably to this it may be said, that as there are several kinds of acids, and of alcalies too, it is not every acid, that will be mortified by every alcali, and have its effects destroyed by it; which may be illustrated by this: that though, when copper is dissolved in *aqua fortis*, it is possible, by the help of mere chalk skilfully applied, to make the menstruum let go the corpuscles of the metal; yet if upon such a high coloured solution of copper you shall pour (as, to convince some ingenious men, I have purposely done) a due quantity of spirit of urine, or the like volatile alcali, though there will presently ensue a great conflict and manifest ebullition, with noise and store of bubbles, yet between these hostile salts a multitude of the acid corpuscles of the *aqua fortis* will not be so mortified, as to let go the metal, but the solution, varying its colour, will have and keep a deeper one than before.

AND when I consider the differences, that a skilful observer may find between vinegar, allum, chrystals of tartar, juice of lemons, juice of barbaries, the essential salts, (as chymists call them) of those plants, that are sour in taste, to omit divers other acids; I am apt to think, that disordered nature may have, in a diseased body, produced acids of several sorts; which are not particularly known to us; and that some of these may be of such a nature, that none of our common alcalies, as such, is able to mortify them, and which yet may be more mortified, at least by the way of sheathing, by some appropriated, or peculiarly modified corpuscles of a specific remedy: which may be illustrated by what is elsewhere observed, that though neither spirit of vinegar, nor spirit of salt, nor oil of vitriol itself, would, as far as I have tried, dissolve a stone taken out of a man's body, yet spirit of nitre, (which does not dissolve several bodies, that I have found dissoluble in oil of vitriol) will readily work upon it, and thereby lose its corrosiveness.

BEFORE I leave this subject, it will not be amiss to intimate a couple of things, that perhaps you will not think impertinent to it.

ONE of these is, that whereas I not long ago distinctly named acids themselves, and their productions, I did it (not out of inadvertence, but) because I think preternatural acids do not only disaffect the body, whilst they continue sensibly acid, but may, in divers cases, be the causes of some distempers, whereof most men would think them more likely to be the remedies. For though acids be reputed to have an incisive and resolute virtue, and therefore oxymel, and some other acetous medicines, are commended to cut tough phlegm, and spirit of vitriol is used for the same purpose, and to dissolve coagulated blood; yet, as I am willing to grant this virtue unto acids, in some cases, so there are others, wherein I much suspect, that obstructions, and consequently the diseases, that usually attend obstinate ones, may be occasioned by acids, as they coagulate some fluids in the mass of blood, that are disposed to be thickened by them, and by that consistence made unfit to pass with the rest of the circulating blood through the smaller vessels and strainers of the body, where upon that account they make obstructions. This I shall exemplify by the coagulation, that I have made by some acid salts, as spirit of salt, of the white of an egg, especially if, by beating, reduced to an aqueous consistence. And the like coagulation may easily be effected in milk, which may not only be speedily curdled with spirit of salt, but, as is known, by bodies not chymically prepared, as rennet and juice of lemons. And experiments, purposely made, have shewn, that, if some acids be conveyed immediately into the mass of blood, they will coagulate even that liquor, whilst it continues in the vessels of the yet living animals.

THE other thing I lately told you I was to observe is, that though acid corpuscles are those, that modern physicians and chymists are wont to take notice of as hurtful, both in the blood and stable parts of the body, except the stomach, and perhaps some few neighbouring parts, as the spleen and pancreas: and though some ingenious men proceed so far as to impute almost all diseases to the bad effects of acids, yet I am very inclinable to think, that divers maladies and troublesome symptoms proceed from corpuscles, that, whether they be of a saline nature, or not, are different from acids, properly so called: for I consider, that there may be many bodies, which may, as it were, result from the combination of acids with other saline particles, that much alter their nature; as I have elsewhere noted, that spirit of salt will, with spirit of urine, compose a kind of sal-armoniac; and spirit of nitre, with salt of tartar, dissolved in common water, will concoagulate with it into salt-petre, (or a body exceeding like it) and the same spirit of nitre, or aqua fortis, with spirit of urine, or of blood, or the like, will afford a very fusible salt, differing enough from what either of the ingredients was before their conjunction. And it is vulgarly known, that oil of vitriol, and oil of tartar *per deliquium*, do, by their coalition, produce *tartarum vitriolatum*, in which the acidity of the former, and the alcalifateness of the latter, are very much infringed, a third body being by resultancy produced, that differs much both from the former and the latter oil, or rather saline liquor. And when, besides instances of this nature, I consider, how many differing sorts of corpuscles so fruitful a principle as nature may have formed, that, without being acid, may yet have notable and hurtful effects upon the blood, or some particular solid part of the body; it seems probable to me, that there may be other qualities required to mortify or disable these morbid corpuscles, than a contrariety to acid salts; and consequently, that a medicine, that affords corpuscles peculiarly fitted to correct or enervate this particular sort of hurtful ones, may deserve the name of a specific.

AND here I further consider, that as in the body there may be divers coagulations made by saline corpuscles manifestly acid; so there may be others produced by corpuscles, whether saline in taste or no, that are not manifestly acid, but perhaps rather of a contrary nature; which observation being wont to be overlooked by physicians,

cians, and yet, in my opinion, of no small importance, may deserve to be a little the more carefully made out. I have sometimes, for curiosity, made a liquor, that was not in taste either acid or urinous; to which having put a moderate proportion of a distilled liquor, which itself was not in taste either acid or urinous, or lixivate, it would in a very short time, perhaps in not many minutes, be coagulated into so consistent a body, that, though the wide mouthed vessel were held with the orifice downwards, nothing would fall out of it.

I HAVE taught in another (unpublished) paper, that if upon a certain solution (which I there shew how to make) one drop some spirit of urine, or another volatile alcali, there will presently be produced a gelly, whose consistence and colour may make it easily be taken for common starch, ready to be employed to stiffen linnen.

THE like gelly, but more transparent, I have more than once made; without the help of any thing, that is sensibly acid or urinous.

I HAVE also, to convince some virtuosi, shewn them, somewhat to their surprize, a substance I had prepared without the help of urine, or any volatile alcali, (and sometimes almost in a trice) that would in very few minutes coagulate above twice, if not thrice its weight of highly rectified and inflammable vinous spirit into a stable mass.

AND to shew you, that it is not requisite, that a liquor be strongly, or so much as sensibly acid to coagulate an animal substance, as I lately noted, that the spirit of salt did the white of an egg, I shall add, that well dephlegmed spirit of wine will do the same thing as well, if not better.

PROPOSITION III.

Sometimes the specific medicine may help the patient, by precipitating the peccant matter out of the blood, or other liquor (of the body) that harbours it.

THOUGH precipitation be oftentimes a consequent of the mortification of acids, or of alcalies, by corpuscles of a contrary quality, yet I thought fit to say something of it apart; because I have observed, that some acids and alcalies may be put together, without causing precipitation by their contrariety: and, on the other side, that divers precipitations may be produced, where there does not appear any hostility; though I know divers ingenious men, who think this effect itself a sufficient argument, that the hostility of acids and alcalies must be the cause of it: but that should not be taken for granted, but proved by collateral experiments, that do not suppose the truth of the hypothesis itself. But to proceed to our examples; I know (and elsewhere mention) several urinous spirits, that I could mix with acid menstruum, without making any manifest conflict or precipitation; and, on the other side, acids and alcalies, that will make a manifest conflict by their mutual creation; and yet, if they be mingled in a just proportion, will have, for the consequent of their mixture, coalition instead of precipitation; as may be exemplified in certain mixtures of spirit of sal-armoniac (made with salt of tartar, or pot-ashes) and spirit of nitre or aqua fortis; and also when spirit of urine and spirit of salt, being mingled in a certain proportion, convene into corpuscles for the making of sal-armoniac, which the phlegm of those liquors will keep swimming. But that, which makes most for my present purpose is, that there may be precipitations, where, whatever may be supposed, it does not appear, that there is any tumult or contrariety; as when silver, being dissolved in aqua fortis, and the menstruum diluted with thirty or forty parts of distilled water, or of rain water, if clean plates of copper be immersed in the solution,

the metal will be very slowly precipitated out of it, in the form, not of a calx, consisting of metalline and saline parts, incorporated together, but, at least at the beginning, in the form of pure shining scales of silver, almost like the white and glittering scales of some small fishes. There is also a way, by which I have brought dissolved gold to settle about a body, suspended in the solution, in the form of a fine and high-coloured calx of pure gold. But you may easily see an instance of silent precipitation, if you do but rub a little either Roman or Dantzick vitriol upon the well-whetted blade of a knife, wetted with water or spittle; for you will have the steel, almost in a trice, overlaid with a reddish substance, which, by its colour and other signs, appears manifestly to be cupreous. And here I shall advertise you, that it is not only, as is wont to be supposed, out of solutions made with acids, that bodies may be thus precipitated; for upon search I have found, that there are in nature precipitants, that are capable of silently precipitating some bodies dissolved in urinous menstrooms, or others not acid. I know it may be suspected, and that not without colour of reason, that such precipitations may be dangerous by producing heterogeneous corpuscles in the blood, that may be too heavy or gross to be evacuated; and I look upon this as a suspicion, for whose resolution it were fit to consult experience; but in the mean time one may represent,

1. THAT though some inconvenience may happen from the bulk of the precipitated corpuscles, yet that may be much inferior to the danger threatned by the over-active and hostile particles, that produced or fomented the disease.

2. THAT it is not necessary, that all concretions should consist of corpuscles so bulky, as to be too big to be thrown out of the mass of blood; for we see that stony matter, which, as the chymical analysis of it shews, is of a very compounded nature, may be carried to all parts of the body. And I remember I knew a lady, who, a while before she told me the story, had a stone taken out of the lower part of her tongue. And physicians, that prescribe great quantities of mineral waters, impregnated with iron, such as I found those of *Tunbridge* to be, and with sulphur, such as some of the *Bath* waters are, are wont to build their expectations of curing with them, upon a supposition, that they are carried into the mass of blood, and consequently to the innermost parts of the body.

3. THAT yet it is possible precipitations may be made of matters contained in the blood by medicines, that do not get into the mass of it: as physicians give steel in substance sometimes crude, as well as often times prepared, to mortify the acidities of the blood, though the metalline corpuscles do not, for aught we know, pass into the mass of it, but are wrought upon by the matter, that in its circulation is thrown out of it into the stomach and guts, where their operation on it is probably inferred from the blackness, that chalybeats are wont to give the excrements of the lower belly. And if they will have it, that prepared steel, for instance, calcined with sulphur, gets through the pores of the bowels, or the extremities of the capillary vessels, into the mass of blood itself; it will be obvious to demand, why nature should not be able to expel precipitated corpuscles at the same passages, at which such compounded concretions, as those of sulphur and metal, can get in.

4. THAT some may very speciously pretend, that experience has been already consulted about the expediency of employing precipitating medicines. For not to urge, that the learned and judicious *Sennertus* seems to intimate, that, in some cases the febrile matter may be surmounted by being precipitated out of the blood; there is a professor of physic, who, though I cannot assent to some of his principles and doctrines, has delivered several considerable things about fermentation and fevers; and this professor,

by name, *Kergerus*, very solemnly declares*, that for fourteen years he cured above a 1000 febricitants, without bleeding, purging, or sweating medicines, (to which he adds some other sorts) by a single precipitating remedy. I endeavoured to obtain from *Germany* an account of the truth of the matter of fact, but did not receive it; only I found, that a physician of this emperor's does, in a lately published book, declare himself inclined to believe it to be true.

I SHALL much the more easily be induced to think, that great and desirable changes may be wrought in the fluid parts of the body by appropriated precipitants, if that be true, which is unanimously taught by a multitude of physicians, who impute many diseases to the putrefaction of the blood and other liquors of the body. For, though certain reasons oblige me to desire you, not to ask me any questions about the remedy I am going to speak of, because I must not yet answer them; yet I am willing you should, on this occasion, know historically, (what probably you will think strange) that there is in *rerum natura* a certain substance, which is so powerful an enemy to putrefaction, that, when a few grains or drops of it were put into a considerable quantity of water, that had been kept till it stunk so strongly and offensively, that, if I had not known what it was, I should have judged the smell to have proceeded from carrion; this medicinal liquor, I say, (for so I may call it) being diffused by agitation through this abominably stinking water, (which did not appear turbid to the eye) in so very small a proportion, precipitated out of it a very little and light feculency, which being separated, the rest of the liquor was quite freed from all stink; nor did I observe, that the feculency itself had any; and, which is very notable, all this was done in a very few minutes, by a precipitant, whose taste was not at all either bitter, or acid, or urinous, or lixivial: all which are circumstances, that may afford good hints to speculative and sagacious enquirers.

PROPOSITION IV.

Sometimes the specific remedy may work, by peculiarly strengthening and cherishing the heart, and by that means, or without it, the part affected.

THIS observation can scarce be made good, without entering into the controversy, which, for its difficulty and importance, has perplexed divers modern physicians; whether there be any medicines, that have a sympathy with the head, heart, liver, &c. and thereby deserve the name of cephalick, cordial, or hepatic, &c. or, to speak somewhat more clearly, whether there be any medicines, that, in a peculiar manner, do good to this or that internal part of the body. In this dispute the affirmative part has been held, but I doubt upon slender grounds of reason, in

* *Ego ab anno 1649. in hunc diem per integros 14 annos ultra mille febricitantes sine venæsektione, sine purgatione, sine sudoriferis, sine diureticis, sine alterantibus, sine corroborantibus, sine topicis, et siquid præterea unico fere medicamento precipitante, Deo imprimis benedicente, curavi: non considerando, an febris sit intermittens, an continuo, an tertiana, vel quartana (quæ tamen difficilius curatur quam aliæ) nec expectata coctione, nec habito respectu sexus, (ne puerperis quidem exceptis) ætatis, anni, temporis, vel aliarum circumstantiarum: et quidem paucorum dierum spatio, sine residua vel aliquo notabili incommodo, nisi ubi æger ipse per incontinentiam de novo paroxysmos provocavit.* Kergerus de Fermentatione, sect. 3. cap. 3. p. mihi 250. "From the year of
" our Lord 1649. in the space of 14 years I cured above a thousand febricitants, without bleeding,
" purging, or sweating, by the help of a single precipitating remedy, without any regard to the nature
" of the fever, whether it were intermitting, or continued, whether it were a tertian, or a quartan,
" which is harder to cure than any other; yea, without considering any other circumstance either of time,
" place, sex or age, and that in a very short time, without any danger of relapse, and without any
" considerable trouble of the patient, if, through his own intemperance, he fell not into new fits again.

most of the physic schools for several ages. But in our times, many do not only maintain the negative, but deride the opinion they have forsaken: for some of them object, in a triumphant style, that it is ridiculous to fancy such a sympathy betwixt a dead medicine, and the parts of a living body, as that the physician may send the drug, as it were, of an errand, to find out one in the dark, among a multitude of others, and do it good offices.

BUT notwithstanding this, I think it very possible, that a medicine may so far respect a particular part, as, though not to be beneficial to that only, yet to be friendly to that, in a particular manner or degree; and this I conceive it may be, upon one or more of the accounts, that I shall briefly mention.

AND first, when I consider that the stable parts of the body, as the heart, brain, liver, kidneys, &c. have each its particular structure, wherein it differs from others, and probably the fluid parts also, as blood, gall, lymph, &c. have their distinct textures; it seems not improbable to me, that the corpuscles of a medicine dissolved in the stomach, and carried to and fro by the liquors of the body, may, according to the determinate shape, size, stiffness or flexibility, motion, &c. be much more fit to be detained by one part of the body, as the brain, the heart, &c. than by the rest; and so, by lodging itself in its pores, or associating with its fibres, may supply it with such congruous particles, as it either does want, or in case it do not, may by their congruity be of advantage to it, by re-establishing or strengthening the tone of it. And by this corroboration the part may be made able to resist the hostilities of morbid matter, which physicians usually observe to be wont, by the more vigorous parts, to be thrown upon the weakened or distempered ones: as is manifest in persons, that are much subject to the gout, in whom oftentimes peccant humours are very apt, upon several occasions, to be thrown off by the nobler parts, if they be robust, upon the frequently debilitated joints; on which score the gout, if it be well managed, is, not irrationally, wont to be thought conducive to long life: and on this occasion I remember, that I formerly knew a learned physician, who, though a great traveller, and, as such, accustomed to great varieties in point of diet, had such a peculiar indisposition in his jaw, that though he could moderately drink wines of several sorts without inconvenience, yet the drinking even of a very little brandy, would soon after give him the tooth-ach, of which odd distemper he has sometimes complained to me. But this upon the bye; for I must now proceed to illustrate and make probable, what I was saying of the possible fitness of some medicinal corpuscles to associate themselves with those of the parts they are to befriend, by observing what happens in nutrition, especially in that of sucking children; for in these one single aliment, namely milk, does afford, besides various excrements, such as the grosser fæces of the guts, and the more fluid ones of the bladder, the mouth, the nose, the pores of the skin, &c. a great number of corpuscles, that are not only detained, but assimilated by parts of differing structures, as the brain, the heart, the bones, &c. since otherwise these parts could never be so plentifully nourished by them, as daily to increase in all their dimensions; and it is considerable, that some parts, which in babes are cartilaginous, do in process of time become bony; which change seems not probably referrible to the bare exsiccation, produced by native heat increasing with the person's age.

SECONDLY, the friendly corpuscles of a specific medicine may not only confirm the good estate of a determinate part, but, which makes most for our present purpose, they may very much conduce to restore it to a sound condition, when it is distempered; and this they may do upon two or three accounts.

FOR, in the first place, those friendly particles may dispose the obstructing or other morbid matter to be more easily and safely expelled; and this they may do, not

barely

barely as they impregnate the whole mass of blood, and so may be carried by it, as well to many other parts, as to that we now consider; but as by their particular texture, motion, &c. they may in a peculiar manner respect that peculiar modification, which the peccant matter may have acquired by being produced or harboured in that determinate part. And that the distinct structure of an affected part may much diversify the condition of a morbid matter, I argue from this, among other things, that physicians are wont to teach (though I have found the observation rather to hold commonly than unreservedly,) that in those, that are subject to the stone, the petrescent matter, when it is bred in the kidneys, is reddish or yellowish, but when in the bladder, white, or of a light grey; and that the stones, that are generated in the first named parts, are more friable, or at least of a slighter texture, than those, that have their original in the bladder, some of which are exceeding hard, especially in comparison of large ones, that I have had out of the bladder or gall of lusty animals. The aptness then, that the corpuscles of the specific may give the blood, or other liquor, that conveys them, to act as an appropriated menstruum upon the peculiarly modified matter that obstructs, or otherwise disaffects the liver, for instance, may enable the remedy to be very helpful to that part, by preparing the molesting matter for expulsion; but it may also succour the same part in another way.

For in the second place, it may so work upon the fibres and stable portion of the part affected, as both to enable it and excite it to free itself from its enemy; for it may give firmness, and strength to the fibres of the part; it may also contemporate, or correct the immoderate heat, coldness, &c. of it; it may mortify the acid, or other incongruous particles, that are lodged in the minute intervals of the stable parts, and perhaps even in the pores of the fibres; it may appease its convulsions, cramps, or other inordinate motions, that hinder it from daily executing its proper functions; it may relax or widen the pores, according to the exigency of the work to be performed: and having thus, by means of its friendly corpuscles, prepared the matter to be expelled, and disposed the part to expel it, it may then also excite the part to do its office, by irritating the fibres, or motive organs, or stimulating them to disburthen the part of the matter, that offends it; as a very small dose of cantharides is known, by this way of irritation, to be capable of making the bladder forcibly, though not safely, discharge itself of urine, and with that oftentimes expel the sand and gravel, or lesser stones, and the excrementitious slime, that molested it before.

AND this instance may be of use to us in answering that, which we formerly noted to be so confidently urged by the rejecters of specific medicines; for here we have a medicine, though a dangerous one, whose corpuscles have such a peculiar reference to the bladder and urinary organs, that, though being gotten into the mass of blood, they are carried by it indiscriminately to other parts of the body, as well as to these: yet oftentimes, without manifestly disaffecting the rest, they exceedingly irritate the bladder, and determine it to the excretion of what it contains. And whereas it may be objected, that the first of the three ways, by which we noted, that a particular part may be succoured by a specific, seems contrary to the second; the former tending to corroborate the part, and the latter to relax and irritate it: I answer two things; one, that since the part may be sometimes in a natural, and sometimes in a preternatural state, in the former a medicine may deserve the name of friendly or appropriated, because it keeps it sound, which is most properly done by strengthening it; and in the latter it may merit the title of a specific, because it helps to restore it to a state of soundness: and the other, that though, to effect this recovery, it is often very expedient, if not necessary, that the medicine procure an evacuation of some matter, that offends it; yet that evacuation itself is often much promoted and facilitated, by
strength.

strengthening the part so, as to enable it to disburthen itself: and the same medicine may contain, and communicate to the blood, corpuscles of such differing shapes, sizes, motions, &c. as may at least successively relieve the part by both these ways; as physicians observe, that rhubarb does, not only by its finer and laxative parts, purge the liver of choler, but by its more earthy astringent corpuscles strengthen the tone of that part: [what farther belongs to the illustration of this matter will be met with in due place.] On this occasion, it will not be impertinent to add, that, in some cases, this very corroboration of a distempered part may restore it to soundness; there being some diseases of such a nature, that they are, if I may so speak, almost always in *feri*, that is, they could not continue to subsist in the affected part, unless through its debility, and the consequences of it, it were subject to admit from time to time fresh recruits of peccant matter to foment the malady: and in such distempers, if the structure and tone of the part be re-established by the operation of the specific medicine, its acquired vigour will enable it to resist the ingress of new supplies of peccant matter, and turn them off into the mass of blood, to be thence discharged by the common sewers of the body: whilst, in the mean time, nature will be able by degrees to subdue, dissipate, or otherwise dispose of, that comparatively little portion of peccant matter, that was lodged in the diseased part.

WE have not in this paper given any example of the peculiar respect of a specific medicine to a determinate disaffected part, that one would think so incredible, as that a heavy stony substance, being in no great quantity taken in at the mouth, should manifestly contribute to the cure of a broken bone in one of the limbs, as the leg or the hands; and yet, not to urge the testimony of chymical writers, I remember a German physician, that was famous for notable cures, related wonders to me of the efficacy of that stone growing in his country, which from its effect they call *osteocola*, especially if it be improved by a skilful preparation, which he communicated to me, but I had not opportunity to make trial of it. But, without preparation, the judicious and long experienced chirurgeon *Fabricius Hildanus* much commends, upon his own observation, a single drachm of it, finely powdered, for the breeding of a callus, to solder together the parts of a broken bone; insomuch that he gives a caution to use it but sparingly in young and vigorous patients, lest it breed too great a callus, of which he gives a notable instance: and the like caution was inculcated to me from experience by the lately mentioned German doctor, because otherwise, he said, his preparation would in such persons make the medicine generate a callus too soon and too great.

PROPOSITION V.

Sometimes a specific medicine may do its work, by producing in the mass of blood such a disposition, as may enable nature, by correcting, expelling, or other fit ways, to surmount the morbid matter, or other cause of the disease.

HE, that shall heedfully observe the practice of divers learned and successful modern physicians, may discern, that many, if not most, of their prescriptions, are founded upon a supposition, that a great part of the diseases incident to man's body, and the recovery from them, depend mainly upon the vitiated constitution of the blood, and the restoring it to a sound condition.

THIS advantageous change of the blood may be effected by a specific several ways, (sometimes separately, and sometimes jointly,) and particularly by those, that follow.

I. THAT,

I. THAT, which I shall first name, is, by furnishing the blood with some sort of active corpuscles, that it needs to ferment it, or excite an useful commotion or agitation in it.

I WILL not here examine, whether the mass of blood, contained within the vessels of a living man is capable of a fermentation, properly and strictly so called; and therefore I employed also the word commotion, which will be easily admitted, if the other be disliked: but in regard fermentation is a term, that hath generally obtained, I shall not scruple to make use of it, after what I have intimated about it.

BUT because many modern physicians, especially since the learned Dr. *Willis's* notions came to be in request, have looked upon fevers and agues to consist in, or be produced by various fermentations of the blood; I thought fit to add to the fermentation I am about to speak of, the distinguishing epithet of useful.

THIS premised, it seems not improbable to me, that as there is oftentimes a vitious fermentation of the blood, so there may be sometimes a want of fermentation, or a certain sluggishness, upon whose account either the brisk intestine agitation, that it ought to have as a warm fluid of such a nature, as it is wont to be in sound persons, or a due quickness of circulation through the heart, is wanting; to which sluggish state of the blood, if it be obstinate and lasting, several distempers are wont to be consequent. Now, although there be divers medicines, such as spices, brandy, and other spirituous liquors distilled from fermented vegetables, that are usually, and oftentimes successfully enough, employed to correct this dull indisposition of the blood; yet in regard they are wont to be very hot, being usually pitched upon by those, that prescribe them, because they are so, there are several constitutions of patients, and divers other circumstances, wherein they are not safe, but may do more harm by their immoderate heat, than good by their spirituousity; besides that the sluggishness of the blood may sometimes proceed from causes, that this sort of hot medicines will not correct. I remember, that having, for trial's sake, moderately dried a parcel of human blood, a vinous spirit totally inflammable would not, at least in many hours, that my experiment lasted, make a solution of it, or draw a red tincture from it, though it were well pulverised; whereas a well rectified urinous spirit grew red upon it in less than the tenth, or perhaps the twentieth, part of that time.

Now a specific medicine may abound in corpuscles of such a nature, that without dangerously or incommodiously heating the blood, they may disable those corpuscles they meet with in the blood, that make that liquor viscous or ropy, or dispirited; and also by enlivening the mass of blood, if I may so speak, or putting it into a more brisk and kindly agitation, may make it fit to throw off those heterogeneous parts, or recrements, that were blended with it before, and to permeate, as freely as it ought, the viscera, whose capillary vessels and pores would formerly scarce, and but very sparingly, admit it.

THAT a specific may perform this, you will perhaps the more easily allow, if you consider, that the generality of physicians teach, that there are several cordials, which they style some of them temperate, and divers of them cold, (as in effect it is not usually observed, that they considerably, if at all sensibly, heat the body) as pearls; and some of them, being gratefully acid, should rather cool it, as wood-sorrel (*alleluja*) and goat's-rue (*galega*.) And it is very possible, that the corpuscles, that make the blood thick and sluggish, may not be of a cold nature, but of a hot, and therefore may have their effects rather befriended than destroyed by divers hot remedies: as, if the white of an egg be, by beating, reduced to water, (which is not necessary to the experiment, but shews it better) if you put to it a certain proportion of well dephlegmed spirit of wine, instead of destroying the viscosity of the liquor, it will curdle a

good part of it, and thereby produce a body far more remote from thinness and fluidity.

AND I remember I once, for trial sake, made a vegetable liquor, which, from somewhat sluggish that it was before, did presently, by the addition of a little spirit of wine, grow surprisingly viscous and ropy.

2. ANOTHER way, by which a specific may befriend the mass of blood, is, by imparting to it a dilatation or tenuity, that it wants. This second way is of much affinity to the first, but yet is not the same; because in that, the thing mainly considered was the fermentation or agitation of the blood; whereas this mainly respects the consistence of it, which is a thing of no mean importance to health. For if the blood be too thick, as oftentimes it is, it cannot pass so freely and readily, as it ought, through the capillary vessels, which thereby come to be by little and little obstructed, and the circulation inconveniently retarded; whence it is easy to foresee, that divers mischiefs must in time arise. And on the other side, if the blood be too thin, especially if it be over much agitated too, it is apt to make its way out of the vessels, and produce hemorrhages, in case it flow out of the body, or other bad effects, that usually attend the extravasation of the blood; which liquor, when it is out of its proper vessels in so warm a place as a living human body, is very subject to putrefaction, and thereby apt to produce imposthumes and several mischievous symptoms.

Now a specific medicine may remedy this faulty consistence of the blood, by furnishing it with corpuscles fitted by their figure, bulk, motion, &c. to disable those peccant ones, that make the blood gross, or else to cut, or divide the parts of the blood itself, and so dispose them to be more fluid; or else they may produce in it such pores, as may, as it were, invite the subtile ætherial matter, that abounds in the atmosphere, to insinuate itself into the mass of blood, and rarify it: and on the other side, when the blood is too thin, as not only some diseases but some medicines, especially aloes, are wont to make it; a specific remedy may reduce it to a good consistence, either by furnishing it with corpuscles apt to combine themselves with the active ones, that did too much attenuate the blood; or by helping nature to expel those over-busy particles, by insensible transpiration, or some other undisturbing way.

3. THERE is yet another way, by which a specific remedy may conduce to rectify the state of the blood, and that is, by so working on the heart, as to make it advantageously regulate the transmission of that liquor through it.

THAT a specific medicine may peculiarly befriend this or that particular part, and consequently the heart, is granted by the generality of physicians, who are wont to reckon up many cordials, (of which yet I fear but few deserve that name.) But since it is elsewhere in this paper shewn, that some medicines may particularly respect a determinate part of the body, and consequently the heart; one may be allowed to suppose, that the corpuscles of a specific may either dissolve some particles they meet with in the heart, by which that noble viscus is by irritation, or otherwise, disturbed in the regularity of its dilatations and contractions; or so corroborate the fibres, or motive organs of it, as to dispose it to moderate the circulation of the blood, that passes through it, in the most advantageous way. And that the disposition of the heart, even when men have no sense of it in the part itself, may be of moment, as to health and sickness, will appear credible, if we reflect on two things; one, that a living human body is not a meer aggregate of flesh, bones, &c. but an exquisitely contrived, and very sensible engine, whose parts are easily set a work by proper, though very minute agents, and may, by their action upon one another, perform far greater things, than could be expected from the bare energy of the agents, that first put them into motion: the second, (which supposes the first,) that the disposition of the heart being, though perhaps insensibly

sensibly, changed, it may produce a notable alteration in the motions of the blood, and its passage through the heart, in point of quantity, celerity, or both.

How much this change in the circulation may in many cases conduce to sickness or recovery, may partly appear by the effects of vehement or durable passions of the mind; as it is observed, that in a deep sorrow, which does in a manner straiten the passages of the heart, the blood being too sparingly dispensed, the enlivening spirits are not generated plentifully enough; and (besides other bad effects of this state of the heart) the blood is so dispirited, as (in these parts of *Europe*) to dispose the body to the scurvy, which does either produce or irritate divers other maladies. We see also, that the passion of shame does oftentimes suddenly alter the motion of the blood, and make it swell the little vessels, that lie under the cuticula of the face, and sometimes other parts; as is very manifest in young maids, and other persons of a delicate complexion, the white part of whose faces in blushing turns red. The like effect I have seen produced by a great and sudden joy. And through grief, which is the opposite passion to it, has been usually taken notice of, as a thing, that deadens the appetite to meat; yet so much does depend upon a well moderated transmission of the blood, that it has been observed in divers persons, and I have known an eminent instance of it, that great joy has very much lessened hunger: of which effect Mr. *Des Cartes* ingeniously attempts to derive the cause from the varied dilatation and motions of the heart. And it seems not absurd to conceive, that such like motions may be caused by the corpuscles of a specific medicine; which by affecting the fibres of the heart, after the like manner, that joy is wont to do, may produce in it such friendly dilatations and contractions, as are wont to flow from the agreeable passions: in favour of which conjecture, I shall take notice, that a lady of my acquaintance has complained to me, that the smell of perfumed gloves is wont to make the blood fly to her face, and continue there for a great while, giving it such a colour, as if shame, or joy had covered it with blushes; and the like, she says, she has observed in others of her sex. But having in another tract spoken of the power of the passions of the mind to alter the state of the body, by producing changes in the blood, that is transmitted through the heart; what has been said may now suffice to make it credible, that a specific remedy, by peculiarly befriending the heart, may contribute much to introduce, or re-establish a healthy crasis in the blood; and this being thus rectified and invigorated itself, may both befriend the body in general, and conduce to the removal of some particular diseases, by strengthening, and, perhaps too, exciting the particular part, in which the peccant matter resides, to subdue or expel that, which it already harbours, and resist any accession of more. And the blood, being itself well constituted, as well as the stable parts corroborated, the specific medicine, that produces these good effects, may be said to cure, though perhaps but slowly, divers particular diseases; such as those, elsewhere mentioned in this paper, which, to continue, must be frequently supplied with vitious matter by the circulating blood.

PROPOSITION VI.

Sometimes a specific remedy may unite its particles with those of the peccant matter, and with them constitute a neutrum quid, that may be easily proscribed, or not necessary to be expelled.

THIS I take to be one of the most proper and genuine ways of doing good, that belongs to a specific medicine, as such, because in this operation an effect is produced, either without the assistance, or beyond the meer power, of the manifest qualities

lities (as physicians call them) of the remedy; and the cure or relief the patient finds is usually attained without violence, and without tormenting or much disordering him.

THIS way of working of a specific medicine is of near affinity with one or two of those formerly discoursed of; but yet these ways differ in some things, as may be gathered by the sequel of § this discourse. § Sometimes when a certain kind of acid has impregnated the blood, or lodged itself in some stable part, as the liver, spleen, kidneys, &c. the corpuscles of a specific may, without any sensible luctation or conflict, which usually happens, when acids are mortified by sapid alcalies, be so qualified, as both to make coalitions with the small parts of the peccant acid, and with them to constitute little concretions, which, differing from the minute parts of the acid, either in bulk, figure, solidity, stiffness, motion, or in two or more of these; may be quite of another nature, and of a much innocenter, than the acid was before it was so corrected. Of this we may be furnished with a notable illustration, by what I have elsewhere taken notice of about *aqua fortis* itself; for as corrosive a menstruum as that is, yet by digesting it, and perhaps distilling it too, with an equal, or rather double weight of ardent spirit, I found the highly acid liquor would be so changed, as not to retain any sensible corrosiveness, and exchange its piercing stink and great acidity, for a not only inoffensive but pleasant scent, and a grateful and positively sweetish taste; which brings into my mind the practice of a president of the famous *London* college, who (as himself told me) was wont to relieve a patient of very great quality in nephritic torments, by giving her a good dose of an inflammable spirit. But this upon the bye. I have elsewhere given an account of the effects of spirit of wine upon several other acid menstrooms, wherewith I mingled and digested it; by which it may appear, that it does not work upon them uniformly, as they are all of them acids, but differing enough, according to the nature and proportion of the acid corpuscles, with which the vinous spirits are brought to be associated.

AND to shew, that this change and contemperation of the menstruum by the spirit of wine is produced rather by a peculiar fitness of the convening corpuscles of both, than by the contrariety or hostility, that the vinous spirit, which some moderns will have to be an alcali, has to the *aqua fortis*, as an acid; I shall add, that pure spirit of wine being mixed in a due proportion with highly rectified spirit of urine, which is reckoned by chymists among volatile alcalies, and of which a drop or two is so fiery upon the tongue, as to be ready to burn it, or to blister it; this vinous spirit, I say, will very much take off the caustic penetrancy of the urinous one, and compose with it a salt much more moderate, than the spirit was, and which being sublimed, or (which is better, but harder to be done,) reduced into a liquor, affords a mixture of no little use in some fevers and other diseases, as a medicine; and with a small, if skilful, alteration, is of great use in divers chymical experiments, as a menstruum.

A FEW grains of glass of antimony, made without addition, being taken inwardly, will vehemently both vomit and purge: but though wine, notwithstanding its copious spirits, will, if it be well impregnated with the corpuscles of this glass, work upwards and downwards violently enough; yet if spirit of vinegar, that is, of degenerated wine, be for a competent time digested upon this glass finely powdered, and, when the liquor is sufficiently impregnated with the particles of the glass, be abstracted from it, there will emerge from the antimonial and acetous corpuscles a multitude of minute concretions, of which many grains may be given without ordinarily provoking either vomits or stools: which correction may hint, that it is not necessary that all mortifications usefully made by medicines should be of acids, since here we see, that acids themselves

selves prove correctors: and perhaps it may be by such kind of combinations, that some poisons (for I do not think they all work one way, or peculiarly assault the heart) may be subdued. And I have sometimes suspected, that it may as probably be upon this account, as upon any, that has been offered, that a man stung with a scorpion may be cured, by crushing the animal, that stung him, upon the hurt; as is prescribed by many physicians, and as an acquaintance of mine told me he tried upon himself (as another virtuoso did on a soldier) with good success. And when I consider what a multitude and variety of figures may fit the corpuscles, that are endowed with them, to make coalitions very different from both the component parts; I can scarce think it very improbable, that in a patient's body there may be made, between the corpuscles of the peccant matter, and those of a medicine, such useful combinations, as may produce resulting concretions, innocent, if not also beneficial.

If I had leisure, and thought it fit, I could easily add a great number of instances about such changes of colours, odours, tastes, and other qualities, as are produced by the coalescence of the small parts of differing bodies, and discourse of the natural consequent of such coalitions; but that having done that sufficiently in other papers, it will be here more proper to intimate to you, that when a particle of peccant matter comes to be associated with one of a specific medicine, that combination may alter it for the better, not only by changing its bigness and figure, but also by increasing, or lessening its stiffness and solidity, and giving a new modification to its motion; as a little attention to the natural consequences of the coalitions of bodies may easily induce you to grant.

AND I shall add (as it were *ex abundanti*) that the small concretions, made by the union of some morbidic with some medicinal corpuscles, may not only become innocent, but sometimes also beneficial; which may be illustrated by what happens by a further preparation to common sublimate: for though this be a substance so highly corrosive and mischievous, that a few grains of it may suffice to kill a man; yet by making a coalescence of it with less than its weight of quicksilver, which is a body insipid as well as inodorous, the corrosive sublimate will be so altered and tamed, as to be turned into what chymists call, because it is freed from sharpness, *Mercurius dulcis*; which, if it be skilfully prepared and given, though in the quantity of many grains, is not only for the most part an innocent thing, but a very good medicine, and that perhaps in more cases, than physicians generally know it to be good in.

THE newly mentioned account may hint to us a probable argument to shew, that notwithstanding all the digestions and changes that a specific medicine may receive in its way, it may prove a salutary one, when it arrives at the part it should relieve. For though the corpuscles of the medicine should in their way to the part affected be considerably changed, yet it is possible, that these altered corpuscles may, by that very alteration, be made medicinal; since they may be qualified (even by those changes) when they arrive at the part affected, to combine themselves strictly with some corpuscles, whether morbidic or others, that they find already there; and may with them compose new concretions, that may acquire a new nature very friendly to the patient. Something analogical to this we may observe in asparagus, which, being eaten, afford store of particles, that, mixing with those they meet with in the kidneys or the bladder, produce a new odour very differing, both from that of meer urine, and from that of the plant itself. And so if good turpentine be taken at the mouth, it is known, that, arriving at the kidneys and bladder, it will mingle its minute parts with those it meets with there; whence will emerge corpuscles, that will impregnate the urine with

a very differing odour from that, which belongs to either of the liquors, since it oftentimes has a fragrantcy somewhat like the smell of violets.

BEFORE I conclude this paper, it is like it will be thought fit, that I should take notice of a difficulty, that I know may be objected, if not against the past discourse, yet against the sufficiency of it to answer the design I propose to myself in writing it. For it may be said, that whereas my arguments and explications suppose all along, that the specific remedies are taken in at the mouth; it is known, that divers of the assertors of specifics reckon among them some, that are not by swallowing taken into the body, but only outwardly applied, or perhaps do but barely touch it; as may be observed in amulets, rings, &c. On occasion of this considerable difficulty I have, if I misremember not, represented divers things in another tract: but however, it may be fit in this place briefly to say somewhat, by way of answer to it. We may then take notice, that the confidence, with which many physicians reject, and some of them deride, external specifics, if I may so call them, seems to be built upon these two things: the one, that the medicine cannot in part, as it is certain it does not in the mass, get into the body; and the other, that in case a specific should have some part of it subtil enough to gain admittance, that part must be too small and inconsiderable to be able to produce in the body any such notable change, as is necessary to the expulsion of peccant humours and the conquering of a disease.

As to the former of these grounds, I largely enough shew in another paper*, that a man's skin, though it seems an entire continued body, is really perforated with a great multitude, and perhaps a not inconsiderable variety, of little outlets and inlets, which we call pores; many of which are visible, even in the skins of dead animals, by good microscopes, and others are manifestly inferred from the numerous little drops, that cover all the skin at the first eruption of sweat. And that these little perforations may be inlets to the finer particles of externally applied medicines, may appear probable by several phænomena, such as these: that water will soak through the pores of a fine bladder, and dissolve salt of tartar, or even white sugar, contained in it: that I have prepared a certain liquor, whose fumes, though not agitated by heat, would quickly penetrate divers membranes of dead animals, and manifestly work on metalline bodies wrapt up in them: that it is a known thing, that quicksilver outwardly applied in ointments, girdles, &c. will get in at the pores of the skin, and invade the internal parts of the body, and stay there longer, and perhaps too operate more, than the physician desired. And when once the effluvia of these externally applied remedies have gained admittance at the pores of the skin, it is not very difficult to conceive, how they may proceed further; for underneath the cuticula or scarf-skin, and close to it, there are so great a multitude of capillary vessels, that you can scarce thrust a small pin into any part, but that the point of it will meet and tear some of these little vessels; as will appear by a small drop of blood, that will be made to issue out at the new made hole, as small as it is: to which instance, if it were necessary, I could add divers others of the multitude and spreading of the capillary vessels, that lie close beneath the skin, and for the most part carry blood, though some of them may contain other juices, and discharge their recrements by sweat, or insensible transpiration, at the cutaneous outlets. Now these capillary vessels, as small as they are, having their cavities immediately continued with those of less slender ones, and by their intervention with those of the greater, which are branches of the greatest of all; the corpuscles of the medicine once got into the capillary vessels may have an easy passage, by means of the liquors they contain, into these greater branches of the principal veins, and so, by virtue of the

* The paper here meant is the essay of the porosity of bodies.

circulation, come to be quickly mingled with the mass of blood, and by it may be easily conveyed to all the parts of the body: as it has been oftentimes observed, * that arsenical amulets worn upon the breast, did, though they scarce touched the skin, produce threatening distempers in the heart, and several mischievous symptoms in other parts of the body. And I find it recorded in good authors, that cantharides, even when but held in the hand, nay sometimes though but carried in one's pocket, transmitted their hurtful effluvia as far as the bladder, and excited great pain and other bad symptoms there.

As for the second ground, on which specific remedies are rejected, that though they could get entrance into the body, yet it would be but by their effluvia, and these are no way likely to prove efficacious enough to have any considerable effect upon an internal disease; to remove this difficulty, I shall briefly observe,

1. THAT the number of the corpuscles, that may pass from the outward medicine into the body, may be far greater, and therefore make them more considerable, than most men are apt to think. This may be rendered probable by the great multitudes of odorous, and consequently sensible expirations, that are continually emitted for a very long time together by ambergrease, musk, civet, and much more by skilfully made compositions of them. And that also subtil effluvia, even without the assistance of heat, may quickly penetrate membranes so plentifully, as to act on stable bodies contained in them, I have intimated a little above, and have experimentally made appear to divers curious men.

2. THAT the corpuscles of a medicine may retain their nature, and not lose their power of operating, notwithstanding their being, as it were, strained through the skin; as may be argued from the mercury, that we not long since mentioned to have been found in the form of quicksilver in the bodies of some men, that had been too frequently anointed with mercury, mixed up with unctuous things into an ointment; by which the patient may be as long and violently salivated, as if he had swallowed a bolus or pills with mercury.

AND so I have divers times observed, as I doubt not but others have oftner done, that a little opium, mixed up with other ingredients for plaisters, did by outward application take off the acute pains of inward parts, though moderately remote from the plaister.

3. AND that the corpuscles of a specific may on divers occasions act more powerfully, by getting in at the pores of the skin, than if the remedy, that afforded them, had been taken in at the mouth; because if it had, the particles might be divided, or perhaps on other accounts, (as by dilution, composition with those of the chyle, &c.) much altered, by the ferment or the menstruum of the stomach, by their filtration through the guts, and their long and winding passage through them and the lymphiducts, before they arrive at the heart to be mingled with the blood: whereas the corpuscles of the external specific, presently after they are past the skin, get into the capillary vessels of the blood, that lie under it, and by their means are speedily mixed with the circulating mass of that liquor, and so escape the formerly mentioned alterations, that other medicines are subject to before they are admitted into the mass of blood. By which it may appear, that those physicians are much mistaken, that think a topical medicine can at best relieve but the part it is applied to, because its corpuscles cannot be supposed to reach beyond that part of the body, that lies very near the medicine they issue from. But though this reasoning might be excusable enough, if not allowable, before the circulation of the blood was discovered; yet now it is

* See this at large proved by the learned *Diemerbroeck de Peste, lib. 2. cap. 11. in Annot.*

known, how great an intercourse that liquor maintains between distant parts of the body, the argument is not seasonable.

AND on this occasion I shall add an advertisement, that I remember not I have met with in authors: which is, that bodies outwardly applied may prove specifics for some diseases or distempers, that one would not think them very good for by the bare knowledge of their effects when taken in at the mouth. Thus camphire swallowed is, in the dose of a very few grains, a great heater of the blood, and is, in some countries, perhaps not altogether without reason, extolled by physicians in some kinds of ill conditioned fevers; but outwardly it is applied to take off those rednesses of the face, that are thought to proceed from heat of blood; and it is used in ointments against burns. So spirit of wine, that is so hot when drank, is a very good remedy to take out the fire, as they speak, in burns, especially if the part be early moistened with it. Bread, that is counted so moderate and well tempered an aliment, when eaten, if it be chewed and outwardly applied, hath considerable virtues in several external affections. And I know an ancient and experienced physician, that uses to purge children, that will not easily be brought to swallow medicines, by applying something to their navels, that does not offend them by colour, smell, or griping; and this himself more than once confessed to me is but an ordinary aliment, that most men, and I among others, have frequently taken unprepared, which he freely named to me, but which I have not yet had opportunity to make trial of.

THAT what we have been saying about the possible efficacy of external specifics, may appear the less improbable, it will be fit to take notice of some observations, that comport very well with our doctrine. And though the instances to be brought will not be all of them of remedies, that deserve the name of specifics; yet besides that some of them may perhaps have a title to it, they will all conduce to shew, that simples or drugs, externally applied, may have considerable operations against internal distempers of the body.

It were easy for me to mention a great many external specifics out of physicians books; but I purposely forbear it, because, to speak freely, I suspect, that most of those remedies, though greatly extolled, have been but little examined by the deliverers of them; and it may suffice, for my present purpose, to alledge a few instances, that have been recommended to me, either by my own experience, or that of some friends: only there is one observation, that is so solemnly and expressly delivered by *Galen*, upon his own knowledge, and so well backed by other eminent physicians, that I shall let it lead the way. This memorable story, that is related by *Galen*, is of a piony root, which having been worn, as an appensum, about a boy, that had been epileptic for divers months, kept him from his disease as long as he wore it about him; but when, by an accident, he ceased to do so, the disease invaded him again, and yet, by applying the remedy again, he was the second time freed from it; which *Galen* observing, did, for curiosity, make the root be laid aside; but finding the fits to return, he employed it again with the former success.

I LIVED in the same house with a learned and judicious person, that was subject to be paralytic, who being frequently tortured by violent cramps, was ordinarily and speedily relieved by wearing or handling the tooth of a true hippopotamus, or river-horse; and he affirmed to me, that upon leaving off the use of it for any considerable time, either out of curiosity, or to accommodate some friend, the fits would return with violence upon him. I remember also, that having myself been for some years frequently subject to cramps, and complaining of it to a physician, that had been a traveller into cold countries, he told me, that he had brought home with him some rings made of the true elk's hoof, from a place, where these animals are usually employed,

and that with these he had cured many of the cramp; and there-withal presented me one to make trial of, which I the more willingly accepted, because he confessed to me, that divers rings, that were sold for such as his, and looked like them, were either counterfeit, or of no efficacy: and though I did not find, that if the cramp seized me in the calf of the leg, the ring would much relieve me, yet when the fits were but moderate, and in other parts, especially the hands, I found myself eased so often and so soon, that I was at first surprized at it, and used to have the remedy laid every night by my bed-side, to have it ready, when occasion should require. And that, which I thought somewhat strange, was, that several times, when the cramp seized my foot or my toes, the pain was quickly removed, though I applied the ring but to my finger; which made me much regret the loss of it.

AN eminent physician speaking to me one day of a patient of his, that was subject to a nocturnal *incontinentia urinae*, that was very inconvenient, as well as shameful; I told him of an empirical remedy, which is mentioned in another paper, whose success I neither would warrant, nor did altogether despair of, and which, at least, seemed safe, though it should not prove effectual. This was only a simple substance (belonging to the animal kingdom) that was to be worn in a fine sarsenet-bag between the shift and the skin; for which, a good while after, the physician gave me great thanks, telling me, that he was surprized at the effect of it, and that he observed, that when the patient had worn it so long, that probably the virtue began to decay, that is, in my sense, the effluvia were almost spent, the patient found need to take a fresh remedy, to continue the benefit she had found by the former.

I do not affirm or expect, that the three forenamed appensa, nor the other remedies I am about to mention, will always succeed; and I think one may assign some, not improbable, reasons, of the want of uniformity in their effects; but for my present argument, it suffices, that they do sometimes succeed, since that is enough to shew it possible, that outward medicines may operate upon inward distempers.

HAVING one day given a visit to one of the skilfullest and candidest physicians of the famous college of *London*, I observed in his chamber a fine new-fashioned clock; and having taken notice of it to him, as a thing I had not seen there before, he desired me not to think he was rich and vain enough to purchase so dear a rarity; but that it belonged to a courtier, whom he named to me, of whose daughter he told me this story: this young lady had a great tumor in her neck or throat, which being apprehended to be of a scrophulous nature, made her father fear it would oblige him to increase her portion more than his estate could conveniently bear: wherefore at length he addressed himself to my relator, who judging the case to be difficult, and being unwilling to torment the lady with a long course of physick, told the courtier, that if he could animate her to suffer a remedy he would propose, and would assist him to procure it, he hoped to remove this tumor, without weakening her, or putting her to pain. Soon after, all parties being agreed, and the desired conveniency procured, the patient was brought into a room, where there was yet in bed the body of a man, that had died of a lingering disease; this man's hand the doctor took, and laid it upon his patient's tumor, keeping it there till she either complained or confessed, that she felt the coldness of it penetrate to the innermost parts of her tumor. This application was afterwards repeated more than once, whilst the body continued without smelling; and by this course the tumor was dispelled, and the patient so relieved, that her father, by way of gratitude, knowing how much the physician was a lover of curiosities, made him a present of that clock.

THE learned doctor ascribed this odd remedy to *Helmont*, who is indeed to be thanked for having mentioned and recommended a medicine, that was unlikely to be good, besides that it was not in use: but the knowledge of it seems to me to have

been, for the main, very much ancients than our age; since there is mention made of one very like it by so ancient a physician as *Pliny*: though, since his time, till *Helmont's*, it hath been generally forgotten or disbelieved, save that one physician (*Franciscus Ulmus*) who, though no ill observer, has not had the fortune to be famous, takes notice of a case very like that of our courtier's daughter, affirming, that by that one remedy, after others had been fruitlessly employed, he knew a noble virgin to have been perfectly cured.

I WAS one summer, to my great surprize, obnoxious to frequent bleedings at the nose; for which I sometimes used one remedy, and sometimes another, for the most part with good, but not still with quick success: but falling once unexpectedly into a fit, whose violence somewhat alarmed me, I resolved to try an unusual remedy; and having easily obtained of my sister, in whose house this accident happened, some true moss of a dead man's skull, which had been sent her by a great person, for a present, out of *Ireland*, in which country I found it less rare and more esteemed than elsewhere, I was going to employ it after the usual manner, which is to put it up into the patient's nostrils; but before I did it, I had the curiosity to try, notwithstanding the briskness of my hæmorrhagy, whether the medicine would produce its effect by being only held in my hand; and therefore covering a piece of the moss with my fist, that the warmth might a little actuate the medicine, I found, to the wonder of the by-standers, that the blood speedily stopped, nor, thanks be to God, have I been troubled with a hæmorrhagy for some years from that very time. But this is far less strange, than what was affirmed to have happened to one of the eminentest members of the Royal Society: this learned gentleman, who was of a very sanguine complexion, found himself much affected by the use of the moss of a human skull, [pieces of which I have seen sticking to the roots of the vegetable, when it was genuine] which had so strange an operation upon him, that sometimes, when he was let blood, if, for curiosity's sake, he held a quantity of this moss in his hand, the efflux of the blood would cease, till he laid it by again; which was not only solemnly averred to me by himself, but confirmed to me by his ingenious physician, with both whom I had a particular acquaintance, which otherwise I should have thought scarce credible, unless imagination, a faculty very strong in that gentleman, contributed to the strange effect of the remedy.

THE hitherto mentioned external specifics are afforded by vegetables and animals, which, being bodies of a slighter texture, may be supposed to have their parts more effluable; and therefore I shall now add two or three examples afforded by the mineral kingdom, which consisting of bodies, that never were living, and which are, for the most part, very close and compact, are generally thought to have their parts indisposed to emit effluvia.

I KNEW a person of great learning, and, by profession, a physician, who enjoyed a health good enough, save that usually after a few hours sleep, he waked in the night with great terrors, followed, for a long time, with such violent palpitations of the heart, as were very troublesome, and sometimes frightful to him. To remove this distemper, he tried all that his art suggested to him, but without success; whereupon he complained of it to several of his acquaintance, and mentioning it one day among a company of merchants, whereof some frequented very remote countries, one of them told him, he would easily relieve him by a remedy, that had been found efficacious, both upon himself and others. This he told him was, to take divers flat and smooth Cornelian stones, such as they bring from the *East-Indies*, to cut rings out of; and to sew eight or ten of them to a piece of scarlet or flannel, to be hung about his neck, so as that the stones may immediately touch the skin over-against the heart, and the mouth of the stomach. This remedy the physician procured, and, in no long time, found the

the great benefit of it, insomuch that he thought he might now securely leave off the use of these stones, which he did once or twice out of curiosity, as well as for his ease; but finding the distemper to return each time, within very few weeks after he had laid aside his remedy, he resolved to keep it always on, as he had long successfully done, when he told me the story; and, to convince me, presented me with some of the Cornelians, that he had, for fear of wanting them, procured in greater number than he needed at once. But since I have not yet had occasion to make trial of them, I shall not conclude, that the remedy will always succeed, but only (which is enough for my present purpose) that it is at least possible, that such an external remedy may be very effectual.

I AFTERWARDS thought (which I here note, to add to the probability of what I have been relating) that possibly those, that first made use of the fore-mentioned remedy, may have had a hint from what *Galen* saith of the jasper; which stone we observe to be various in point of colour, and I have seen in the green mixtures of red almost as deep, as that of Cornelians. Of this stone *Galen* relates, that some made rings, in which were graven a dragon, having beams issuing from him, and commended it as very friendly to the stomach, being applied to the mouth of it: and though he omitted (and found he safely might do it) the sculpture, he yet approves the stones upon his own frequent experience, applying them almost as our merchant did; *Sane hujus* (says he) *ego quoque lapidis abunde feci periculum, torquem enim ex hujusmodi lapillis confectum collo suspendi, ita ut lapides os ventriculi contingerent; apparebant autem nihilominus prodesse; etiamsi sculpturam non haberent, &c.* “I have made myself a frequent trial of this stone, having carried several of those little stones tied together about my neck in such a manner, that the stones did touch the mouth of my stomach; yet they were beneficial, though they had nothing graven upon them, &c.

*Galen. de
simpl. Med.
Fac. lib.
nono. Tit.
de Lapid.*

I HAVE lately mentioned the efficacy of a cramp ring upon some parts of the *genus nervosum*; but some will perhaps think it more considerable, if a stone ring, worn on the finger, shall be able to work on the mass of blood, and particularly that depraved portion of it, that nature relegates to such distant parts, as the hemorrhoidal veins: and yet the experienced *Monardes*, having described the blood-stone, that is brought from *New Spain*, and represented it as a jasper, not only commends it against hemorrhages, being applied to the bleeding part, but adds the following words, which declare, that he speaks upon experience; *Vidimus nonnullos hæmorrhoidum fluxu afflictos remedium sensisse, annulos ex hoc lapide confectos in digito continue gestando: necnon et menstruum fluxum sisti.* “We have seen sometimes the hemorrhoids cured, as likewise the copious monthly issues, by wearing rings made of this stone.”

*Nic. Mo-
nard. Simp.
Med. Hist.
cap. 36.
p. 329.*

I KNOW you will expect here, that I should not on this occasion permit the *Lapis Nephriticus*; of which sort of stones, though many have been found ineffectual against the disease, that gives them their name, and though it be scarce possible to chuse those few, that are good, without having particularly and actually tried them; yet that some of them are of great virtue, we have the testimony of the inquisitive and judicious *Boetius*, and that other learned writer about gems, *Jobannes de Laet*, whose praises are confirmed by the historical testimonies of *Monardes* and others. But none, that I have met, speaks more home to our purpose than a considerable merchant of *Leipsick*, whose rare observations are recorded by a man of very great reading, the learned **Untzerus*, to whom I refer you, contenting myself to mention, in this place, two of the ten remarks he sets down; the first, that the merchant affirmed to our author, that by wearing this stone for some days, the calculous matter was so powerfully proscribed, that a multitude of small grains of sand were expelled, even at the corners of his eyes. The like effect to which he often observed of that remedy in divers other persons. The

*Untzer. de
Nephrit.
lib. 1. cap.
24.*

second, that by wearing the same stone, his wife, who was troubled with a great catarrh, found it considerably cathartic, inasmuch that the first day she was thereby purged fourteen or fifteen times, the next nine or ten times, and afterwards had her body kept very open. And he adds, that he found also this stone to operate like a purge, though not so strongly, upon himself.

BUT enough, if not more than enough, of the virtues of periapta and appensa, especially since more instances of them may be met with in some other papers; and even without them, or at least with them, those particulars, I come from mentioning, may furnish a sufficient answer to the objection, that has occasioned them.

THE CONCLUSION.

AND now, Sir, you have what the consideration of the nature of the things I treat of suggested to me, about the principal ways, by which I conceive specific medicines may cure diseases, or at least much lessen them. I said, the principal ways, because I am far from denying, that there may be many others, that must not here be mentioned, lest I should too much transgress the limits, that become an epistle; especially this being already far more prolix than I at first intended; though I purposely omitted the authorities and arguments of divers physicians and chymists, that maintain, that there are specific medicines, because they proceed upon principles, (such as substantial forms, real qualities, ideas or chaosses, and the like,) which I could not fairly employ, because I do not admit them. But though I forbore to lengthen my discourse, by improper, and, I hope, needless transcriptions out of others: yet it is long enough to prompt me now, at the close of it, to remind you of two or three things, that I declared at the beginning.

As first, that I did not pretend, that a specific medicine, or nature by a specific, does commonly effect the cure by one of the particular ways, that I proposed, exclusively to the rest: since I rather think, that oftentimes two, and sometimes more, concur to the effect. Secondly, that I proposed to myself, to explicate the ways of working of specific remedies, only in general. And thirdly, that I did not assert, that the ways I pitched upon were the true and genuine ones, by which the medicine does act, but only propounded them, as ways, by which it may act. So that, without being dogmatical, I offer you my explications, but as possible, and perhaps not improbable; and that may suffice for the occasion and scope of this letter, in which, I presume, you remember I aimed but at shewing you, that the operations of specific medicines are not irreconcilable to the principles of the corpuscular philosophy; which I hope you will, without reluctance, grant, if, by my good fortune, the difficulties, that made you hesitate, seem to you to be lessened by so barren an intellect as mine, discoursing of an abstruse subject, which belongs to a profession, that I am not of. Upon which account it may be justly presumed, that you, who have so much more sagacity, and are so much more concerned, than I, in the subject I have been treating of; and who, being a professed physician, have much more opportunity to discover the various courses, that nature does, or may, take in curing diseases, will be able to give yourself far more satisfaction, than you could hope to receive from me, who have therefore proposed to you my conjectures very diffidently, though I am very positive in asserting myself to be,

SIR, your most, &c.

ROBERT BOYLE.

T H E
A D V A N T A G E S
Of the U S E of
S I M P L E M E D I C I N E S,
P R O P O S E D
By Way of I N V I T A T I O N to it.

S E C T. I.

To the very learned Dr. F.

S I R,

SINCE specific medicines, to deserve that name, must be very efficacious, and yet are, for the most part, either simple, or very little compounded; what has been said about them in the foregoing tract, concerning specifics, may afford me a not improper rise to invite you, and thereby others of your profession, on whom your authority and example may justly have much influence, to seek after and employ, more than they are wont to do, such remedies, as are either simple, or, when there happens a necessity to compound, are made up of no more ingredients, than are absolutely requisite to answer the indications, and the physician's scope.

THIS sort of simple, or but lightly compounded, remedies, I am induced to prefer before those pompous compositions, wherein men seem to have hoped to surmount diseases by the multitude of the ingredients, upon the following reasons; in all which I desire the advantages ascribed to simple medicines, above others, may be understood, not in an absolute and indefinite sense, but, as they speak, *cæteris paribus*, which I here give you notice of once for all.

AND the first advantage, that I shall mention, is, that it is much less difficult to foresee the operation of a simple, than of a very compounded medicine; so that physicians may proceed more securely in employing the former, than the latter sort of remedies. And indeed, if I do not greatly mistake, we often presume too much of our own abilities, when we believe, that we know before-hand, what the qualities and effects of a mixture of many ingredients of differing natures will be; since many bodies, by composition, and the change of texture, consequent thereupon, do receive great and unexpected alterations in their qualities. Several manifest instances of this truth may be met with in our history of colours; in divers of whose experiments, the colour produced upon the mixture of bodies is quite different from that of any of the ingredients; as, when a blue solution of copper, made in spirit of urine, does with syrup of violets, which is also blue, produce a fair green: and even since I began to write this section, a trial purposely made, has afforded me a new instance of the same import.

FOR having put together some tincture of iron, made with good spirit of vinegar, and a volatile tincture of sulphur, (which I elsewhere shew how to make) from a confusion

fusion of these two very red liquors, there emerged, in a trice, a very dark and almost inky mixture, that retained nothing at all of redness.

THE like notable changes I have several times produced by mixtures, in divers other qualities of bodies than their colours, as in their odours, tastes, &c. and why such alterations may not be also effected by composition in some of the medicinal qualities of bodies, I do not yet see? Quicksilver itself, inwardly taken, does usually cause, either no manifest evacuation, or one, that is made at the mouth; but if it be dissolved in spirit of nitre, and precipitated with sea-salt, this white precipitate beingedulcorated, if it be warily given in a just dose, doth (as far as I can yet learn) seldom work by salivation, but by siege. On the other side, glass of antimony (made *per se*) whereof a very few grains, given in substance, are wont to work violently upwards and downwards, being dissolved in spirit of vinegar, (which is not easily and quickly done) will not usually either vomit or purge, though the menstruum be drawn from it, and though it be given in a larger dose, than that of the uncompounded glass.

AND though, if crude antimony be fluxed with nitre and tartar, as in the ordinary way of making crocus metallorum, there is produced, as is vulgarly known, a medicine so emetic and cathartic, that an ounce or less of the wine, wherein it has been infused, without sensibly losing its weight, is wont to work strongly enough both upwards and downwards; yet I have known some, that would without scruple take several grains of crude antimony in substance, and one particularly, that continued the use of it long, without being vomited or purged by it. And trials purposely made have informed me, that if, instead of salt-petre and tartar, antimony be prepared with well dried sea-salt and a little salt of tartar, though both these amount not to above half the weight of the nitre and tartar vulgarly used; yet the antimony well fluxed with these (for about an hour) is thereby so altered and corrected, that it affords an useful medicine, of which one may give from 12 or 15 grains to half a drachm, or more, in substance, without ordinarily working, either by vomit or siege, but usually by sweat, and sometimes by urine: whence we may gather, that antimony may be either made a dangerous, or a more friendly medicine, than of itself it is, according to the ingredients it is associated with, though these be in themselves innocent, and perhaps of kin to one another. And even chymists, as well as other prescribers of remedies, may be found, though less frequently, to add to a simple such things, as rather deprave, than improve it: as one of their great patrons (a happy practitioner) complains, that flower of sulphur, by being sublimed, (as by many it is) from calcined vitriol, and one or two other things, under pretence of purifying and subtilizing it, does really acquire a hurtful corrosiveness. And, if I had here the leisure, instances enough might be brought to shew, that chymists sometimes mistakenly produce, by their additions to a medicine, other qualities, if not also worse, than they designed or expected.

S E C T. II.

ANOTHER advantage of simpler medicines is, that *ceteris paribus* they are more safe than compounded ones, especially if the patients be valetudinary persons. It is too much the custom, both of many herbarists, and several other writers on the *Materia Medica*, to give us rather encomiums, than impartial accounts of the simples they treat of; enumerating and magnifying all the virtues they have, and sometimes more than they have, without taking notice of their ill qualities, upon whose account nevertheless they may be inconvenient, if not hurtful and dangerous, to some constitutions, and in divers cases. We know, that divers perfumes, as musk and amber,

ber, though very grateful and refreshing to most men's spirits, are yet very hurtful to many women, and especially to those, that are hysterical. And I have known the smell of musk very much disaffect an eminent person, though otherwise of a robust constitution. I have also known several persons, not all of them of the same sex, very much offended by the smell of roses, which yet is very moderate, as well as to most persons, whether men or women, very grateful. I know a very great person, to whom honey, whether inwardly taken, or outwardly applied, is almost as hurtful as poison, having several times produced strange and frightful symptoms, even when the patient knew not, that any honey had been employed, and consequently could not be thus oddly distempered by the force of imagination. I think I have elsewhere taken notice of the harm, that both I and others, subject to diseases of the eyes, have received, even by the moderate use of parsley.

ON this occasion I shall add what occurred to me long after I had dictated what I said of parsley, that wormwood, though for many uses an excellent plant, has been found by many so apt to disaffect the head, and so unfriendly to the eyes, that I have for some years forborn it myself for fear of the head-ach, and forewarned others of it, that are subject to weak eyes. But I know a very learned man, whose elegant pen has made him deservedly be taken notice of by many, who, though he have naturally very good eyes, found upon an obstinate trial, that his curiosity seduced him to make, of the plentiful use of wormwood-wine and beer, that within less than three weeks his sight was by degrees brought to be so weak, that he could not read a *Gazette* without spectacles; but by totally leaving off wormwood, he quickly recovered the vigour of his sight, without the use of any of the helps, that his profession, which is physic, would have plentifully suggested to him. This relation I had from himself, soon after the thing happened, on occasion of what I told him about parsley, &c.

AND to speak more generally, I doubt not, but if men were not so prepossessed with the praises, that authors give to simples, that they overlook the inconveniencies they may on divers occasions produce, we should find in many medicines bad qualities, that are not yet taken notice of. And I have more than once hit but too well in the prognostics I made of the hurt some patients would receive by the use of applauded medicines, prescribed them even by considerable and learned men, when upon their authority my warnings were neglected, and the use of the medicines unhappily persisted in. I remember I once saw, in the hands of a learned and curious traveller into the eastern parts of the world, an Arabic manuscript about the *Materia Medica*, which made me regret the loss of the most part of the little skill I once had in that language; for besides that it was written in a delicate hand, and the letters in fit places curiously adorned with gold and azure, the method seemed to be more accurate, than any thing I had seen on that subject: and that, which pleased me not a little, was, that the author had been so wary, that after the columns, wherein he taught, besides many other things, the virtues, doses, &c. of every drug he treated of, he had a distinct column for the bad qualities of it, and the constitutions and diseases, wherein the use of it may be dangerous or inconvenient. I think it therefore not unreasonable to suspect, that, where a great many ingredients are blended into one medicine, one or other of them may have other operations, besides that designed by the physician: it may awaken some sleeping ferment, and, if not produce a new distemper, may excite and actuate some other hostile matter, that lay quiet in the body before, and perhaps would have been little by little subdued by nature, if it had not been unreasonably roused and assisted by some ingredient, that perhaps was needlessly put into the medicine. I have had so many unwelcome proofs of this in myself, that it engages me to be the more careful to caution others against the like inconvenience.

S E C T III.

ANOTHER benefit accruing from the use of simpler medicines is, that thereby the patient may, without burthening his stomach, or nauseating the remedy, take a larger dose of the medicine, or of that ingredient of it, wherein the virtue chiefly resides. For, whereas physicians are obliged to stint themselves in the dose of the medicine, for fear of disgusting the patient, or oppressing his stomach; when there are many things heaped together in a moderate dose of one compounded medicine, these ingredients that are either superfluous, or at least are less efficacious, must necessarily take up a considerable part of that determinate dose, and consequently leave much the less of the more appropriated or useful ingredients.

To say, that all the ingredients, that are thrust into a great composition, are proper and conduce unto the same purpose, I doubt is not always true; and however is not a sufficient answer, since it does not avoid the inconvenience I have been objecting.

If a baker, being to make the best bread he can, especially for a person of a weak stomach, should, to wheaten flour add the meal of rye, of barley, and of oats; though all these ingredients be good and nourishing, and each of them is by many used to make bread, yet none will take him for a skilful baker, and few would prefer this compounded bread, to that more simple one made of wheat alone. And so to make good gunpowder, a skilful man would not to salt-petre, brimstone, and charcoal, add wax, rosin, and camphire, though these be very inflammable substances as well as sulphur. And thus if one would make an *aqua vitæ*, whereof but one small cup were to be given for the quick recovery of fainting persons, he would not with spirit of wine, or good brandy, mix mead or cyder, and strong beer or ale, though each of these be itself a spirituous liquor.

GUM Arabic (whereof I prefer that, which is transparent and colourless) is prescribed in several compositions, as a drug proper to mitigate the sharpness of urine; but by the quantity of the other ingredients, that it is mixed and clogged with, no more than a small proportion of it usually comes to be given in one dose: but when I have had the curiosity, leaving out all the other things, to give about a drachm, or perhaps more of it at one time, reduced by long pounding (for the best is very tough) to fine powder, in a large draught of beer, or some other convenient vehicle, I found very considerable effects of it. And I remember, that a gentleman of great note coming to bid me farewell, because of a long and troublesome journey he was taking to mineral waters, which he intended to drink for many weeks, to ease him of a very painful sharpness of urine; I, that knew it was not venereal, nor from the stone of the bladder, (for when those are causes of the strangury, the medicine is not near so powerful) desired him, before he went, to make use of this powder, once, or (if there should be need) twice a day; which when he had done, it so relieved him, that he thought himself quite cured, and forbore his intended journey, not only that year, but the next. For the chin-cough, as they call it in children, whose odd symptoms do usually frighten the parents and attendants, and oftentimes frustrate the endeavours of physicians skilful in curing other coughs, I have not known any magisterial composition so effectual, as the simple juice of pulegium (by many called penny-royal) sweetened a little with sugar-candy, and given long enough from time to time, in the quantity of a child's spoonful. (This plant may be also made to afford a syrup, that will keep, and is useful in coughs, but which I doubt is not so efficacious as the simple juice.) There are many and obvious experiments of the great efficacy of so simple a remedy as asses milk, (which yet in some cases, I think inferior to goat's milk,) if

it be given in a sufficient quantity, and for a competent time. There are also many instances of dangerous and stubborn diseases, that have been cured even by common cow's milk, when it has been very plentifully taken, and for a long continuance of time: and perhaps, it is no less remarkable, that in a far less time, now and then, not extending to very many days, fluxes, as diarrhæas, and though more seldom, even dysenterical ones, are happily and easily cured, as I have sometimes known, by the bare use of so slight a remedy as milk, wherein, whilst it is gently boiling, an equal quantity of fair water is little by little put, till at last there remains but as much liquor, as the milk alone amounted to at first. This simple alimentous medicine being liberally taken (for it should be used instead of all other drinks, whilst the disease continues) has been very frequently found to cure fluxes, not all of one sort, in Ireland itself, where that kind of disease is endemical. And, though I have formerly in another paper recommended the use of *Paronychia foliis rutaceis*, against that sad and stubborn disease, the king's-evil; yet I presume you will allow me, by the mention of a trial, that was since made with it, to give a notable confirmation of the utility of giving an alterative simple, if need require, in considerable quantity. A physician, that I knew, was sent for to a scrophulous patient, in whose throat there was a tumor, so big and so unluckily seated, that, much compressing the œsophagus, it rendered deglutition exceeding difficult; so that being likewise so hard and stubborn, that though the physician was also a famous surgeon, he could neither discuss it, nor bring it to suppuration; the patient, though rich, was in imminent danger of being starved. In this strait the physician remembering the character I had given of paronychia, or whitlow grass, sent about the country to get all that could be procured; and at first gave a little of it, in form of infusion, in such liquid aliments, as the patient was able, by little and little, to get down: and having by this means, after some time, made the deglutition less difficult, he gave the remedy more and more plentifully, to imbue the whole mass of blood and juices of the body with the virtue of the herb; whereby the tumor was at length resolved, and the patient secured, so much to the physician's reputation as well as profit, that, as he said, he thought gratitude obliged him to give me a circumstantial account of his success; as he very civilly did in a long letter, whereof I have given you the substance.

AND though I might here entertain you with the virtues of some other simple remedies plentifully given, yet for brevity's sake I shall rather observe in general, that I doubt not but several simple medicines (I speak of alterative, not evacuating ones) would be found far more effectual, than they are commonly thought, if they were given in a much larger dose, and continued for a competent time. And probably so many physicians (especially of the old school,) would not be so forward to reject either specific or simple remedies, as having found some of them not to answer expectation, if they would allow them as fair a trial, as they give to their own prescriptions; such as the chalybeats of the shops, the Spaw, or Tunbridge waters, the decoctions of guaiacum, &c. which they often give with divers intermediate helps for a month or six weeks, and sometimes for two months together, without expecting, that in a few weeks, much less in a very few days, they should perform the cure.

S E C T. IV.

THE fourth thing, that may recommend the use of simple medicines, is, that *cæteris paribus* they are more easy to be procured than compounded ones. This assertion needs little proof. And where several simples are required, one or more of

them may oftentimes be difficult to be got; and all of them will still be troublesome to be fetched, and to be made up into a composition. How useful the knowledge of parable remedies may be, I have endeavoured to shew in a distinct paper: and therefore shall not discourse of it here, but only add this one observation, that some medicines are so parable, that without resorting for them to apothecaries shops (which are not every where at hand, nor always furnished with them) we may find them in those of other tradesmen. Thus among masons and bricklayers, we most commonly meet with quicklime; whose bare infusion in common water [about a pound of the former, as it is more or less strong, to about three or four quarts of the latter,] is of itself a good medicine in divers cases, and, as experience has persuaded me, may be made the basis of several good remedies, both inward and outward; among the latter of which may be reckoned an ointment, that I usually kept by me for burns, and made only by beating up strong lime-water with as much good linseed oil, as could be made thoroughly to incorporate with it into a very white unguent.

AND I shall add concerning linseed oil, (since I have mentioned it) which is to be had in the shops of varnishers and painters; that of itself, being exhibited in a large dose, as of several ounces at a time, I have known it answer the commendations given it by eminent physicians, for breaking of pleuritical empyemas. Simple oil of turpentine also, that may be usually had in the shops of the same tradesmen, is in reality a noble remedy in divers affections, not only inward, in which chymists commend it, but outward too. And I have had great thanks, both from physicians and chyrurgeons, for recommending the use of it to them in wounds, and particularly, where one would expect little from it, in the stanching of blood, if it be seasonably applied very hot to the wounded parts, where it also much promotes a good digestion. And I am confirmed in the good opinion I have long had of this oil, by the information, that is given me, that a very experienced chirurgeon has lately been so charitable, as to publish a little book, considerable for the useful observations it contains, of notable cures done by him in chirurgical cases, chiefly with oil of turpentine. And I shall add, that a chirurgeon to a great monarch, and one of the skilfullest men I ever met with of his profession, confessed to me, that in an admired cure, that he had then lately done of a desperate gangrene in an eminent person, very aged and almost bed-ridden, the medicine he ascribed most to, was the oil we were speaking of. And, because both he and others make much and good use of spirit of wine in gangrenes, which yet is thought to be unminglable with oil of turpentine, because if it be shaken with it, it will quickly separate again from it; I thought it might do practitioners some service, to make for them a mixture of oil of turpentine, and spirit of wine, that might probably be more penetrant than the former, and less fugitive than the latter, which of itself does not stay long enough upon the parts it is applied to: which mixture I easily made, by digesting for a while, and strongly shaking from time to time, about equal parts by guess of good oil of turpentine and thoroughly dephlegmed spirit of wine, till this liquor, by imbibing or dissolving great store of the oleaginous parts, have attained a yellow colour, for which reason I call it the tincture of oil of turpentine.

AND since my subject has led me into the shops of colour-sellers, I will, before I leave them, take notice of one simple, that is wont to be found there, which if it were not very offensive to the taste, and somewhat disagreeable to the stomach, would be perhaps preferable for its antinephritic virtue to the most pompous compositions of the shops, and some of the celebrated arcana of the (vulgar) chymists. I procured it, not without some difficulty, from a spagyrist, very well versed in the school of *Paracelsus* and *Helmont*, who though a sparing commender of remedies, extolled this, as the best he had ever met with, to cure the stone, where it was too big to pass, and to prevent the increase

increase of it where it was. I have known it used in clysters, with very good success, in a fit of that disease; but inwardly I had no occasion to try it but upon myself; and judging it innocent enough (as indeed I found it rather anodyne than driving) I took it now and then, mixed with oil of sweet almonds chiefly to allay the taste (for otherwise I had long found that alone insufficient) as a preservative from gravel. And thanks be to God, I divers times thought it more manifestly effectual to that purpose, by lessening either the bulk of the grains, or the quantity of the sand, or both, than any of the remedies I had taken for several years before: and yet I scarce took a quarter of the dose prescribed by the spagyrist, that communicated the medicine to me; which in short is (for I presume you would gladly know it) to take from time to time, by itself or in some convenient vehicle, two or three ounces of the expressed oil of walnuts, which, if the great staleness of it he requires be necessary, (which I mean to examine by trials) is scarce to be had but at the shops of artificers, because he would have it at least a year old, and judged it the elder the better.

BEFORE I quite leave the shops of tradesmen, I shall take notice of one medicine more, that seems to have been first lodged there, and from thence translated into the shops of apothecaries. The medicine I mean is Castile or else Venetian soap, (for either is often employed instead of the other) which being a body abounding with alcalisite salts and oleaginous parts well combined, invited me to make some experiments with it, as a substance, that may be applicable to good uses, not only mechanical but medical. Of some of the former sort I elsewhere make mention; and as to its medicinal virtues, I take notice in another paper of its efficacy against the jaundice; for which I have since been informed, that, as nauseous a medicine as it is, it is in great request among some skilful men in *Holland*; and some fresh, but not sufficient, experience has recommended it to me against the stone. But that virtue of it, which I as yet most prize it for, and now intend to communicate to you, you will best gather from the following story. Having had some dealings with a considerable merchant of *Cork* in *Ireland*, he sadly complained to me, that he was afflicted with a necessity of making bloody water to that degree, that he feared he must soon quit his profession, being already unable to ride about his business, and scarce able to walk a foot the length of a street, without stooping to make red water. Hereupon I told him I had a medicine, that, if he could digest the unpleasantness of it, would, I thought, by the blessing of God, do good even in this case; and it was only to scrape with a knife as much Castile soap into a spoon, as it would conveniently hold without being pressed, *i. e.* near a dram; and having filled the vacant part with small ale, or some other convenient drink, to facilitate the swallowing so nauseous a remedy, wash it down with a somewhat large draught of the same liquor, or other fit vehicle, repeating the dose twice or thrice a day if need required. The manifest relief he found by this seemingly despicable medicine, within (if I misremember not) two or three days, invited him to continue the use of it a while longer, and afterwards to return me solemn thanks for it; declaring, that now for four years together he had lived quite free from his distemper, without scrupling to ride journeys on horseback, as his occasions required. To which he added, that in regard I had not confined him to secrecy, he presumed I intended the medicine should do as much good as might be, and therefore scrupled not to give it to several others, who were likewise happily cured by the use of the same remedy. Which account was therefore the more welcome to me, because in the place where I lived, I had not opportunity to make further trials of its efficacy. And on this occasion I shall beg leave to advertise you once for all, in reference to the remedies delivered by me, either in this paper, or in my other writings; that I am as sensible

as another of the almost insuperable difficulty of making any certain experiments in physick; and that having of a long time (for reasons given in due place) studiously, though not unreservedly, declined the occasions of giving (and consequently of reiterating) medicines; I justly desire, that none of my readers, and especially that Dr. F. would too much rely upon them, till they have been more competently tried, than perhaps some of them, for want of opportunity, have been; and administered to patients of differing complexions, ages, and other circumstances.

You may find other instances of the virtue of parable, and some of them unpromising medicines, in one of my essays of *the usefulness of experimental philosophy*; to which I the less scruple to refer you, because I do not remember what I have there written many years ago so perfectly, as not to fear, that I might, by enlarging this section, put you to the trouble of reading some things here, that you have met with there already. And yet I am somewhat encouraged both to mention to you that book, and to present you some other receipts in this paper, because it has pleased God so far to bless divers of the medicines I have there recommended, or do there mention, that they have been prosperous to many patients, and not altogether unuseful to some noted physicians; and have procured me from both more thanks, than I pretended to, besides inviting encouragements to further communications.

S E C T. V.

THE last thing in order, but not in importance, that induces me to wish, that physicians would employ simpler medicines as much as conveniently may be is, that it is one of the likeliest ways, (and perhaps little less than absolutely necessary) to promote the practical knowledge of the *materia medica*. For, whilst in one receipt a multitude of ingredients are mingled, if not confounded, it is almost impossible to know with any certainty, to which of the simples the good or bad effect of the remedy is to be attributed, or whether it be not produced by a power resulting from the particular qualities of all of them, united into one temperament, and by its means acting conjointly, and, as the schoolmen speak, *per modum unius*. So that by this way of heaping up or blending simples into one compounded remedy, I see not, how in many ages men will be able to discover the true qualities good and bad of the particular bodies, that are comprized under the name of the *materia medica*; whereas, when a physician often employs a simple, and observes the effect of it, the relief or prejudice of the patient may very probably, if not with medical certainty, be ascribed to the good or bad qualities of that particular remedy.

And this difficulty of discerning, what ingredient it is of a very compounded medicine, that helps or hurts the patient, is much increased to those, who affect to write bills, wherein something is prescribed, which, though, because it goes under one name, it passes but for one ingredient, is yet a very compounded body; as is evident in those many pompous receipts, wherein are treacle, (that alone consists of above sixty several simples) mithridate, and divers other famous ancient compositions, that each of them consists of good store of ingredients. I had once thoughts of drawing up a discourse of the difficulties of the medicinal art, and had divers materials by me for such a work, which afterwards I laid aside, for fear it should be misemployed to the prejudice of worthy physicians. But among the difficulties, that occurred to me, I shall on this occasion mention one; which was, that it is a harder work, than most men think, to discover fully the nature, or the good and bad qualities, in reference to physick, of this or that single plant, or other simple, that has
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a place in the *materia medica*; for besides the great difference, that there may be in plants of the same denomination, according to the climate, soil, the goodness of the seeds, that produce it, the culture, or the want of it, the time of the year, the seasonableness or intemperateness of the weather, the time and manner of gathering it, how it has been kept, the parts of it, that are, and those, that are not made use of, together with other circumstances too many to be here enumerated; besides all these, I say, the unheeded textures of parts, that are thought of an uniform nature, and the length of time, during which they have been kept, without being suspected to be superannuated, and indeed without being so, may so much vary the Nature of a plant, that I have sometimes, almost in a trice, shewn the curious a notable disparity in the parts of the same fresh leaf of a common plant: and (NB.) I have found by trial purposely made, that some seeds of common use in physick (and not putrefied) will, being distilled at one time of the year, afford an acid spirit or liquor; but at another time of the year, though distilled the same way without any addition, afford not an acid, but a kind of urinous spirit, that contains a volatile salt, which in smell, taste, and divers operations, I found to be of great affinity to the volatile salt of urine, or that of hartshorn. And indeed so many things may be pertinently and usefully proposed to be enquired into, about this or that particular plant made use of by physicians, that perhaps they would be less inclined to compound numbers of them in one receipt, if they were aware, how much useful employment the indagation of the qualities of so much as a few single plants would give them: and yet without the knowledge of the properties of the separated ingredients a physician prescribes, it will be scarce possible for him to know, with sufficient certainty, how the compound made up of them will be qualified and operate; which reflection I the less scruple to propose, because I am confirmed in it by Galen himself, which very book, where he largely treats *de medicamentorum compositione*, hath this assertion; *in universum, nemo probe uti possit medicamento compositio, qui simplicium vires prius non accurate didicerit.*

Galen. de
Comp. Sec.
Gen. lib. 1.

I presume you will easily allow, that much of what has been said in favour of those simple medicines we owe to nature's (or rather to its Author's) bounty, may be extended to many of the remedies, that are afforded us by the chymist's art. For without now entering into the question, whether the spirits, oils, and salts, that are obtained by what spagyrist's call analyses by the fire, are principles in the strict sense of the word; it will scarce be doubted, but that the spirit, or the oil, or the salt of a mixed body chymically resolved, is so slightly or unequally composed, that the ingredient, whence it takes its name, is far more predominant, than it was, when combined with others in the entire or not yet analysed concrete. And that such supposed principles, or medicines of a simpler order, may be very efficacious remedies, may be justly argued from the great and beneficial effects of such as oil of vitriol, spirit of urine, (NB.) a medicine of great use both inward and outward, spirit of hartshorn, spirit of nitre, spirit of wine, and oil of turpentine: of which last named liquor I shall add, that, besides the virtues already ascribed to it in this paper, whilst it retains its simplicity, it may in many cases be employed as a menstruum, and, by being combined with an ingredient or two, be made to afford divers medicines, which, though but little compounded, are not of little virtue; for I have found it readily enough to dissolve camphire, mastick, and some other gums, of which balsams may be made, and others may be obtained, by the help of the same liquor, even from divers mineral and metalline bodies. I will not insist on so known a medicine, as the common terebinthinate balsam of sulphur; though this be a remedy, which as much as it is peculiarly extolled for diseases of the lungs, (wherein yet

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its heat requires, that it be very warily given to patients of some complexions) has virtues, that are not confined to the distempers of those parts; since both I, and some I commended it to, have found it very effectual (outwardly applied) in troublesome hæmorrhoidal pains and tumors: and (NB.) some experience inclines me to think its virtues may not be much greater in pulmonick, than in paralytick distempers; in which (last) it may be used not only outwardly, but chiefly inwardly; and that in a pretty large dose with a cephalick, and, in some cases, an antiscorbutick vehicle. But I shall rather take notice to you, that perhaps it will be found worth while to try, at least in external effects, the use of divers tinctures, and consequently balsams, that may be obtained by the help of oil of turpentine from divers solid mineral bodies, upon which I have found by trial, that this liquor may be tinged (though not of the same colour on all of them;) among which I shall name, besides crude zink, crude antimony, and even crude copper (in filings;) a noble subject, antimonial cinnabar, from which, though I found I could (but not hastily) draw a fine tincture, I had not opportunity to make trial of that promising medicine.

S E C T. VI.

AND as for those other medicines, that are not made by bare analysis, but by synthesis or composition; though I think an experienced chymist may, in many cases, with less uncertainty than a Galenist (who employs crude ingredients of a more compounded nature) foresee what quality the produced mixed body may have; yet I could wish, that even the spagyrist themselves were more sparing, than many of them are, in the number of the ingredients they employ to compose one medicine: for most of the arguments, upon which I grounded my invitation to the use of simple remedies, are applicable to chymical ones, as well as others; and on this occasion I shall represent two things.

FIRST, that, in many cases, preparations skilfully diversified may be usefully substituted to composition; since one body, dexterously exposed to differing operations, may acquire as various, or as considerable, qualities, as would accrue to it by the addition of such other bodies, as an ordinary chymist would in probability associate with it. Thus, not to mention quicksilver, antimony alone, whether prepared without addition, as when flowers of several sorts are made of the more volatile, and true antimonial glass of the more fixed part, or being associated but with one or two ingredients, may afford a skilful spagyrist medicines numerous and various enough, almost to furnish a shop; or at least to answer the physician's scope, where he would employ an emetic, a cathartic, a diaphoretic, a deobstruent, a diuretic, a bezoardic, or cordial medicine; to name now no other qualities, that may be found in some antimonial preparations in a degree considerable enough to ennoble them: which instances, and others of the like nature, I presume you will allow me to make use of in this discourse, because, though I do commonly, yet I do not always, employ the term simple medicine or remedy in the strict and absolute sense, but in a comparative one, that excludes compositions of more than two or three, or at the utmost a very few, ingredients.

SECONDLY, without bringing together a chaos, or so much as a considerable, number, of ingredients, one or two, or at most three auxiliary ones, if judiciously chosen and skilfully managed, may oftentimes produce more efficacious remedies, than the admirers of pompous processes would expect, or perhaps be able to make those processes vie with. The violently emetic and purgative virtue of glass of antimon

timony made *per se* may be, as I elsewhere shew, more powerfully corrected by mere distilled vinegar, than by many famous stomachic and cordial elixirs, and other elaborate preparations; and sometimes a seemingly improper addition may not only correct, but give new and unexpected virtues to a drug. Thus, though *sublimatum corrosivum* be a mercurial concrete so fretting, that a very few grains of it may be able to kill a man; yet, by adding, and carefully uniting to it about an equal weight of running mercury, there is obtained, when they are well united by sublimations, a compound, that is so free from being corrosive, that chymists call it *mercurius dulcis*; which though some unwary practitioners, as well Galenists as chymists, have too often, by their misemployment of it, discredited, yet experience shews, that in skilful hands it may be usefully employed, not only in some venereal affections, but in divers other distempers: and I shall now add, that being carefully prepared, and well given, it may not only be freed from corrosiveness, but much allay the sharpness both of some emptying medicines, and of some peccant humours. To countenance the latter part of which observation, I shall acquaint you with one use of it, that perhaps you have not yet made. I remember, I had an opportunity to observe the efficacy of *mercurius dulcis*, in a stubborn dysentery, that had baffled the remedies of an ancient physician. But though a reflection on the virtue I knew this medicine to have of allaying sharp humours, and resisting putrefaction, may justly increase my favourable opinion of it; yet not thinking my experience competent, I imparted it to an ancient and expert surgeon, that was the chief of those, that belonged to a famous and judicious general of an army; who thereupon frankly confessed to me, that this was his great arcanum, wherewith he had cured many scores, or rather hundreds of soldiers in this general's army; only, whereas my way is to give from 8, or 10, to 12, or at most 15 grains of *mercurius dulcis* for a dose, made up with some little rhubarb, &c. or other ingredient, that would make it work once, twice, or thrice with another patient, (for the dysentery itself helps to carry off the medicine;) he, both to disguise it, and to make it more easily takeable, made it up with sugar and mucilage of gum-dragon into lozenges, whereof one might contain from near a scruple to half a drachm of the *mercurius dulcis*, of which he ordered the soldiers to take one at a time, without hindering their march, only bidding them have a great care, that nothing should stick between their teeth, or in their throats.

3. But the efficacy of this simple preparation of mercury is much inferior to that more simple, although more tedious, preparation of gold, which was made the same way in two differing countries, by two dexterous physicians, both of them of my acquaintance. For though I had long been prejudiced (not without specious grounds) against pretended *aurum potabiles*, and other boasted preparations of gold, (for most of which I have still no over-great esteem,) yet, I saw such extraordinary and surprizing effects of the tincture of gold I speak of, upon persons of great note, that I was particularly acquainted with both before they fell desperately sick, and after their strange recovery, that I could not but change my former opinion for a very favourable one of some preparations of gold; and I should have thought, that this medicine (as little compounded as it is,) could scarce be paid by a great store of the noble metal, that afforded it, if it could have been made in great quantity, or without a great deal of pains and time. I can speak thus circumstantially, because by the kindness of the artists, and the pains I had spent in working on the same subject they make their menstruum of, I so far knew, and partly (by themselves invited) saw, the preparation of it, that (to bring home what has been said to the present occasion) I can tell you, that there is no ingredient associated to the gold, save one, that comes from above, and is reputed one of the simplest bodies in nature,

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and of which one may take two or three ounces altogether unprepared, without the least inconvenience; and yet the dose of this almost insipid medicine, that was given to an old courtier, even in a violent apoplexy, wherein other remedies had by skilful men been used in vain, was but six or eight drops.

In another very antient and corpulent person the dose was greater, because the tincture was more unripe and diluted; but the effect was as sudden, though the patient was not bled, and though there was not in either of these two cases any notably sensible evacuation made. [Both these recovered persons are yet alive.] The same medicine awhile after saved the life of another gentleman I know, who, having lain above two and twenty days sick of an ill conditioned fever, was condemned by three physicians, whereof one told me with great grief, that he would not out-live the next morning; and yet upon the taking of a large dose of this tincture, he was presently relieved, and from that time found a sensible amendment towards a recovery, which he now enjoys, though he were then reputed to be about, if not above, fourscore years old. Some other odd effects of this remedy I could tell you of; but it has already much swelled this section; and yet I thought it not amiss to relate these things to you, both because they are very pertinent to the scope of it, and because you may be, as I long was, prejudiced against medicines made of so fixed, and, as is supposed, unalterable a metal as gold.

4. THIS is not the only medicine made of that noble body, of which I have known very notable effects: but, because they belong to another paper, I shall not particularly mention them in this; but pass on to tell you, that the preparation of silver, that I have long since delivered in another book, though it may seem but slight, has been found very effectual, and much used by one of the eminentest physicians of this nation, to whom I recommended it, and who acknowledged to me, that he gave it to patients of very high quality, though disguised, to avoid alarming those, that are fearful of chymical medicines. And since that I gave it to a great lady, that was hydropical, and judged to be dangerously ill, with notable success; and the cure has already for some years held good. But I confess to you, that I look upon copper, and its magistery blue vitriol, as a much nobler subject to make remedies of, than silver, and perhaps than gold itself. And if I were to make physic my profession, there is no metal, which I should so willingly bestow pains upon, as copper, induced thereunto by the excellent and very extraordinary effects, (not all of them to be mentioned in this paper) that I have had opportunity to see of some remedies, which, though I could never learn how to make, I knew were made of that metal, or vitriol abounding in it, but first freed from all cruel violence. And for appeasing pains, produced even by inveterate maladies, the laudanums, and other opiate preparations, that are prescribed and praised in physicians and chymists books, and much used (oftentimes with good success) in their practice, seem to me because of the stupor, and some other inconvenient symptoms they are wont more or less to be followed by, far inferior to the sulphureous parts, as a chymist would call them, of skilfully prepared Venus; these being much more harmlessly and friendly anodynes. And I remember, that an empirick, to whom, at his request, I taught a very uncertain way (for it rarely hits) of making a kind of sulphur of vitriol alone, in the form of a brick coloured powder, came purposely to give me solemn thanks for the reputation he had gained by that medicine, of which, the first time he had the good luck to make it, he gave, as he was instructed, four or five grains of it to a woman, that could not sleep, but had been for divers months raving mad, [maniacæ;] which single dose not only gave her a good night's rest, but brought her to talk sense, when she waked in the morning. I knew also a chymist,

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mist, that was much courted, even by learned doctors, for an internal anodyne he used, and could sell at almost what rate he pleased, to take off inveterate pains in the heads and shins of venereal patients; and the same person cured venereal ulcers in a very short time, only by strewing on them an indolent powder: and though he was so shy, that he would not let even the physicians I recommended to him see his medicine, yet having one day been told of a kindness I had done him, unknown to him; he took it so well, that he not only allowed me to see and handle his medicine, but when I guessed, by the ponderousness and effects of it, that it was some preparation of mercury fixt with sulphur of Venus, he frankly acknowledged to me, that, though it would indure not only ignition, but a strong and lasting fire, that in the former part of my conjecture (that the body of it was mercurial) I was in the right, and in the latter part I shot very near the mark; but added, that the true sulphureous parts of Venus were in his way so difficult to be obtained, and required so much time, that he could seldom prevail with himself, (who indeed was voluptuous enough) to go through so troublesome a work. And in effect I found, upon various trials, the constituent parts of that metal to be much more strictly united, than the generality even of chymists imagine. For the extraordinary effects of this medicine I can refer you to the testimony of very ingenious men of your own profession, (and probably acquaintance too.) And since I know you study *Helmont*, I presume you will the more readily believe them, if I put you in mind of that notable passage, where he says: *Nihil æque victorioso in humidum radicale agit atque primum ens cupri, vel ad vitam longam sulphure vitrioli est benignius; ideoque sulphur philosophorum indigatat.* But my intended brevity forbids me to insist longer on this metal, or to take notice of more than one other metal. And because that of steel physicians as well as chymists make great variety of remedies, some of which are produced by preparations slight enough; and the like may be made of mercury, witness the remedy formerly commended against the worms, made of nothing but crude quicksilver barely decocted in common water: for this reason, I say, I shall pitch upon lead, whose calx dissolved in spirit of vinegar affords, as you know, *Saccharum Saturni*; which, though so easy and simple a preparation, is a magistery, that has more virtues, than every physician knows, or perhaps so much as suspects; especially in mortifying sharp humours in the eyes, which I have known or made it do sometimes almost in a trice: but I do not think it safe to make the plantain or rose-water it is to be dissolved in, considerably strong of it. And for burns, I have seldom seen any thing equal to it, and therefore have often used it upon myself, barely dissolved in common, or else plantain water. But I fear it is not so safe as effectual in some inward distempers of the bowels, that are judged to be caused by acid humours, unless it be very warily and skilfully given. But as to its external use, I presume I need not tell so skilful a doctor as you (NB.) how great it is in healing, and in the mean time appeasing, the pains of divers sorts of ulcers. And therefore, I shall mention but one particular, which it is like you have not met with; namely, that I know a very ancient and experienced person, who, besides a vast practice otherwise, was surgeon to a great hospital; who professing much kindness, and owning some obligation to me, confessed to me, that amongst all the medicines he has tried to stop bleeding, and prevent accidents in amputations, that which he ofteneft used, and most relied on, is a solution of *Saccharum Saturni* in plantain water (or for a need in pure common water:) for having dissolved ʒi. of the former in about a pint or pound of the latter, as soon as ever the limb or other part is taken off, he immediately applies stupes drenched in this liquor, as hot as the patient can well endure; and having bound them carefully on, he makes no haste to take them off, but allows the medicine time enough to

perform its operation: to countenance this I would tell you an odd experiment of mine, of the efficacy of a Saturnine liquor to resist putrefaction in the bodies of animals, but that the relation would take up too much time.

5. PERHAPS I need not tell you, that I could here mention divers other experiments, as well upon Saturn, as upon the other metals I have named above: but that my scope confines me to such preparation, as wherein the metalline subject is compounded but with very few others; and also, that of those, that are more remote from simplicity, you may meet with several in some of my other papers, which I am not in this to defraud.

WHAT has been above noted about metals, may be extended to minerals; namely, that when there is need to compound them, it may oftentimes be sufficient to associate them with one or two, or at most a very few auxiliary ingredients, if I may so call them. This is apparent in several useful preparations of antimony, that are vulgarly enough known, to which divers may be added, that are made of common sulphur by slight additions. Of which sort, because I elsewhere deliver several, I shall now mention but one, which though I have many years ago described in the history of colours I shall not scruple to take notice of here, because I there consider not its medicinal virtues, which yet are very great, especially in asthmas and coughs, in which I do not remember, that I ever gave it without benefit to the patient; nor was it less successful in the hands of physicians, that were willing to try it for me, especially in those of a person, who, though well furnished with choice remedies of his own, often came to me for a supply of this spirituous and penetrating tincture, with which he assured me he did notable things in asthmatical cases; and particularly in one, that was very obstinate, and had lasted many years. But not having had quite so many opportunities, as I wished, of giving it myself, I shall be glad, that further trial may be made of it by so skilful an administrator as you; and therefore, lest you should not have the book lately referred to at hand, I shall here repeat, that our medicine is made of flowers of sulphur, exactly mixed with an equal weight of finely powdered sal armoniac, and somewhat more than an equal weight of good quick lime, separately reduced to a subtil powder; for these three ingredients being diligently and nimbly mixed, and put into a retort, to be placed in a sand furnace, and fitted with a large receiver very well luted to it: this mixture, I say, being duly distilled in such vessels, will afford a blood-red and smoking spirit, exceeding sulphureous both in smell and even mechanical operations. And in this distillation the sulphureous parts sometimes came over accompanied with such store of saline ones, that a good part of what past into the receiver shot into the form of a volatile sulphureous salt. And I remember, that having, for curiosity's sake, added to the fluid tincture a due proportion of an ardent spirit (such as that of wine) exactly dephlegmed, I had a mixture (whether in the form of a coagulum or not) which afforded me some odd phænomena not here to be mentioned, and which we subled with a gentle fire to unite them into a composition, that may for distinction sake be called *sal trium regnorum*, because it contains urinous particles, vinous ones, (and perhaps some of foot) and sulphureous ones; whereof the first belongs to the animal, the second to the vegetable, and the last to the mineral kingdom, as chymists are wont to speak. But what virtues this salt (that would presently gild silver,) and the spirit, that may be made to accompany it, may have in physic, I had not occasion to try; but yet I have mentioned it upon the by, that you make use of it, if you think it worth while to do so; to which I shall here present you with no inducements, since I perceive, that the particulars abovementioned about simple preparations of gold and other metals have already made this section enormously great: and

nd yet I hope you will not be displeased at it; since to so sagacious a person as Dr. F. these passages may afford some not altogether usefess hints; and at least it is an encouragement to industry, to know, that the subjects a man works on are capable of affording excellent things.

S E C T. VII.

1. **I** FORESEE it may be objected against the frequent use of simple medicines, that oftentimes it happens, that a disease, or a morbid matter, is not the effect of a single cause, but is produced by the concurrence of two, or perhaps more, causes; which producing several symptoms, it is not probable, that one simple drug will be able to answer those different indications. This objection I confess is considerable, and there are cases, wherein I acknowledge it to be so weighty, as to invite and warrant a physician to employ in them a medicine consisting of more ingredients than one or two; which I can admit without prejudice to my design, since I formerly declared I did not intend to persuade you to confine yourself to simple remedies (so much as in the late sense above intimated of that term,) but only to employ them, where they may suffice; and where they cannot, to make use of medicines, as little compounded as the case will permit.

2. **BUT** having premised this advertisement, I presume I may offer you two or three considerations, that may lessen the force of the lately proposed objection. And first, though I readily grant, that there are diseases, whereof each may proceed from differing causes, and that a remedy may be available against it, when it is produced by one of those causes, without being so, when it flows from another; yet, it may also easily happen, that in one case the disease may be cured by one simple medicine, and in another by a remedy not compounded: nay, it may also happen, that the same simple may cure a distemper, by which soever of the two causes it is produced. This I have in another paper endeavoured to make out. And what we see of the effects of the Jesuit's powder, as they call it, in different kinds of agues, as tertians, quartans, &c. and of pacating medicines (most of which indeed owe their virtue to opium, but some are mineral, and have nothing of the poppy in them) in appeasing pains produced by humours, and other causes very differing; may keep what has been said from appearing improbable: and, if I mistake not, it may divers times happen, that whatever it were, that at first produced a portion of morbid matter, that first produced matter is the cause of the continuance of the disease, by virtue of some peculiar texture or noxious constitution, which if a generous medicine can destroy, the disease will, at least little by little, cease.

3. **IT** not unfrequently happens, that several symptoms, that seem very differing, may so depend upon the primary or principal cause of the disease, that if a medicine, how simple soever, be capable to destroy that cause, all the various symptoms will, by degrees at least, vanish of themselves; as we often see, that when mercury, though perhaps but crude, is skilfully applied, and raises a kindly salivation, a great variety of inconveniencies, that afflicted a Venereal patient, and seemed to require many differing and topical applications, are removed by the same remedy, insomuch that not only frightful ulcers, but such nodes, as one would think scarce possible to be dissipated by the strongest plaisters, are sometimes happily cured by well prepared quicksilver, taken in at the mouth, as I have been assured by more than one eminent physician upon his own experience: and though not unfrequently there be several, and sometimes very different symptoms, that accompany that disease of children, that in *England* we call the rickets (and of which there die several almost every week in *London* alone); yet that medicine, which I have elsewhere described under the name of *Ens (primum) Veneris*

[made of strongly calcined and well dulcified colcothar of Dantzic vitriol, and elevated with sal armoniac into the form of a reddish sublimate] has proved, by God's blessing on it, so successful, that partly by a sister of mine, (to whom I communicated it) and partly by myself, and those I directed to take it, or to give it, I think I may safely say, that two or three hundred children have been cured by it, and that almost always without the help of any other inward medicine, or using any topical application at all.

4. BUT the main thing, that I intended, by way of answer to the foreseen objection, was, that in a simple medicine nature herself does oftentimes so well play the apothecary, as to render the compositions made in his shop unnecessary. For though we are wont to look upon this or that plant or mineral, as an entire and simple body, yet we may much mistake, if we look upon it as a homogeneous one. In several plants, that are organical bodies, this truth is manifest; as for instance, in oranges the succulent part is sour and cooling, but the yellow rind considerably bitter and hot: and so in lemons the pulp, the yellow part of the rind, and the seeds have their differing qualities and medicinal virtues. And even in such vegetable substances, as are homogeneous as to sense, there may be parts, whose operations may be not only differing, but contrary; as is manifest in the root we call rhubarb, which affords as well notably astringent, as laxative and purgative parts. And so in minerals themselves, good and clean lead ore, for instance, though an uniform body as to sense, consists of very dissimilar parts, and affords sulphureous, and perhaps other excrements, besides malleable lead, which is itself a compounded body. Thus also shining marcasites, though they appear homogeneous, will, by barely being exposed for a competent time to the moist air, afford an efflorescence, that is perfectly vitriolate, and consequently contains an acid salt, two kinds of sulphur, a terrestrial substance, and at least one metal, (for oftentimes it holds both copper and iron, though one predominate,) which last named substances themselves are neither of them simple bodies.

5. AND if we admit the chymical analysis of mixts to be genuine, we shall find, that almost all those, that belong to the vegetable kingdom, or to the animal, and many that are referred to the mineral kingdom, how uniform soever they may appear to the eye, do each of them contain several different, and sometimes hostile substances. Thus hartshorn, though it appears a dry and homogeneous substance, will in distillation afford a volatile salt, an urinous spirit, a waterish liquor, or phlegm, a swimming oil and a sinking one, a white and porous earth, or *terra damnata*, and perhaps some, though but very little, fixt salt. Thus also in the vegetable kingdom, tartar, for instance, may without addition, be made to afford, as experience hath assured me, a volatile salt very like that of urine, a phlegm, an acid spirit, another spirit; to which I have elsewhere given the name of *Adiaphorous*, two foetid oils, whereof one will sink in water, and the other swim on it, an earth, or *terra damnata*, and a fixt lixivial salt, upon which the newly mentioned acid spirit manifests such a hostility, that when they are put together, they tumultuate with noise and bubbles, and in the conflict mortify each other. And thus likewise in the mineral kingdom, not to repeat what I lately said of the compoundedness of vitriol, not confidently to urge the opinion of divers eminent physicians, that *Mars* (as they call steel and iron) affords parts, whereof some are astringent, and others operative, because I am not yet sure these contrary qualities do not proceed from the differing degrees of fire, and other circumstances of the preparations of the metal; we see, that native cinnabar affords, by distillation, besides running mercury, a dry substance, whence I have obtained a sulphur, that would presently gild silver, and a terrestrial substance, whose nature I had not occasion to examine. And I the rather take notice of these differing parts in native cinnabar, because it is a mineral,

mineral, that I much esteem; and though here in *England* it is very rarely, or scarce at all employed as an inward medicine, yet I know some foreign physicians of several nations, that look upon it, as one of their chief arcanums, and both use it, and conceal it, accordingly. But I do not willingly employ it, till it has been prepared, by grinding it exactly upon a porphyry, or other fit stone, as a painter would do to make a pigment of it, and by freeing it from certain salts, that often undiscernedly adhere to it, and sometimes may be hurtful; which is done by first washing it very carefully with boiling water, and then, after it has been thoroughly dried, by burning upon it several times, one after another, some vinous spirits perfectly dephlegmed. The dose, if it be to be long continued, may be three, four or five grains; but when it is to be given but seldom, and, for an urgent case, it may be from six or seven to ten or twelve grains.

S E C T. VIII.

1. **W**HAT has been said in the foregoing discourse, to manifest, that a simple, whether organical or not, may, notwithstanding its intireness, or its seeming homogeneity, contain or afford very dissimilar parts, may help us to conceive, that being really a compounded body, it may afford parts differing enough to answer differing indications, or attain several scopes, that are wont to be looked on by physicians as necessary, or at least very useful to the cure of this or that disease; as in many diarrhoeas, or fluxes of the belly, whereas it is judged requisite first to evacuate the peccant matter, and then to give astringents to hinder the immoderate evacuation, wherein the disease is thought to consist; rhubarb answers both these indications, by its purgative and its more terrestrial parts, whereof the former dispatch their work first, which makes the astringent operation of the latter seasonable and safe.

2. I HAVE divers times observed, that so common and despicable a simple, as ground-ivy, has performed things, whose variety seemed to argue, that it contains parts of very differing virtues, (as of opening, temperating, healing, &c.) and is thereby capable of answering differing intentions, especially in distempers of the lungs and breast; and indeed partly by the syrup of it, partly by the infusion of the leaves, and partly by medicines made of them in a consistent form; the happy effects of this simple have procured me the thanks of divers considerable persons, some of which had before unsuccessfully used many prescriptions of learned men. And I remember I knew an ingenious person, who being master of a considerable manufacture, which was gainful to him, whilst his servants continued tolerably well; was very much incommodated and perplexed to find them so obnoxious to violent cholicks, (which he imputed to the copious steams of the vinegar his art required) that he was forced, almost weekly, to allow them some days of cessation from working, to preserve or recover themselves; and I remember, that from this inconvenience, he was at length, as himself confessed to me, in great part freed, by making his workmen frequently use a strong infusion, or tincture of the leaves of our ground-ivy, made with (not pure or dephlegmed spirit of wine, but) good unrectified *Nantes* brandy.

I COULD here add divers other uses, both internal and external, of this seeming despicable plant, there being scarce any one English herb known to me, of which, for its manifest virtues, the experience of others and my own have given me a greater esteem. And I am apt to think, that the efficacy, which this and some other simples, that the fear of prolixity makes me silently pass by, would be found greater and more various, than they are commonly thought, if physicians, in prescribing medicines, would more often either ordain simple ones, or, at least, associate but very few together, and compensate the small number of ingredients by the greater quantity of those, that

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are the most appropriated or operative, and by persisting in their use for a competent time.

THOUGH it is not every efficacious simple, or but lightly compounded remedy, that can fitly be employed about the proof of what I am now endeavouring to shew, yet I shall subjoin such instances, as will, I hope, suffice for the present occasion.

MINERAL waters, as well *acidule*, as the German Spa, our *Tunbridge, &c.* as *thermæ*, such as those of *Bath, &c.* though but natural medicines, and some of them but outwardly administered, are notoriously known in their native simplicity to be able, one of them singly, frequently to cure diseases, and consequently to take off a good number of differing symptoms, that afford various indications. It may help much to make it probable, that the same simple may comprise qualities fit to answer differing scopes, and thereby cure differing symptoms, if it be considered, that there are several poisons, that do each of them produce symptoms, not only very frightful, but very various, and yet all these have been oftentimes conquered by a specific antidote, that is perhaps but a simple herb, or other uncompounded drug. I had once (and but once) the opportunity of making a trial, whereof I shall now give you a brief account, of the virtue of a stone taken out of the head of an enormously great *African* serpent; which stone was affirmed to the possessor of it, governor of the famous English *East India* company, to be highly available against the bitings of all venomous animals. The substance of the experiment (to give it you in short) was this: I caused a young cat to be bitten by a fierce and highly irritated viper, which so enraged the cat, that, in revenge, he endeavoured to bite off her head, which he took in his mouth, and did not let go, till, as the spectators concluded, she had bit him again, at least by the tongue: soon after which venomous hurt, the cat's head swelled very much, and though he soon grew so weak, that he was not able to stand on his legs, but lay along on the ground, yet he seemed to be grown quite mad, for he foamed at the mouth, and snapped at the end of a wand, or such like things, that were but held near him; and, which was more, in his rage bit one of his own legs, that lay not far from his mouth, much to the surprize of the spectators: but, though in this desperate condition it seemed in vain to attempt any thing for his rescue, because one could make him take nothing, and every one was afraid to come near him; yet having mixed a little of the powdered stone with some spoonfuls of fair water, it was, by the help of the neck of a glass retort, that we employed instead of a funnel, poured, by degrees, upon the cat's mouth, which lying open, though he endeavoured to shake it off, yet some of it was concluded to have got in; and within one hour or two after, if not less, he did, to the no small wonder of the by-standers, get upon his legs again, and not only seemed to have lost much of the tumidness of his head, but readily enough took the medicine I caused to be given him; and would probably have escaped very well, if, whilst I was at dinner with the company, some unruly people had not hurt him more mortally than the viper had done.

PHYSICIANS and others have observed in the plague a great variety of symptoms, among which there are divers, whereof each, if single, would pass for a particular disease. And this diversity of symptoms may be not unfrequently observed, not only in pestilences that happen at times, or in countries, distant from one another, but in the same plague reigning in the same place: and yet it is possible, that a simple remedy may be available against this so multifarious, or manifold (if I may so call it) and violent a disease. Of which observation (to omit what might be alledged out of some other authors) I shall give one instance out of *Galen* himself, who treating at large of the *terra Samia*, takes occasion to bring in the virtues of bolarmony (*bolus Armena*) which I should guess, by his manner of mentioning it, to have been little, if at all, known

known to physicians, till his time. This earth, that appears a body so simple and uniform, he not only commends for several diseases, as spitting of blood, fluxes of the belly, dysenteries, catarrhs, defluxions from the head upon the breast, difficulty of breathing thence ensuing, and even ulcers of the lungs; but adds, what makes very much and directly for our purpose, in the following words: *in magna hac peste*, (whereof he had spoken before) *cujus eadem facies fuit atque ejus quæ Tbucydidis memoria grassabatur, quotquot hoc bibere, celerit curati sunt*. The way of giving it (which I add by the bye, because it may sometime or other be of use) was this; *bibere*, says he, *consistentiâ tenui modice diluto, si aut planè febrî careat, aut leviter eâ teneatur; sin gravius febriat, admodum aqueo*. And so excellent a medicine did this simple one prove in that terrible plague, that our author says, *Quibus non profuit, omnes interiire; scil. nec alio quovis medicamine, juvantur: unde colligiter, concludes he, quod iis duntaxat non fuerit auxilio qui plane erant incurabiles*.

Galen. de
Simpl.
Med. Fac.
lib. 9. Tit.
de Terra
Samia.

3. THERE are few diseases, that put on so many forms, or are attended with greater variety of symptoms, than that, which physicians call *affectio hysterica*, and whose paroxysms, or effects, are vulgarly known in *England* by the name of fits of the mother. And yet we have often removed, and not seldom in a quarter of an hour, or less, hysterical paroxysms and symptoms, and sometimes such, as made the patient swoon, or lye along as almost dead, by the bare odour of well rectified spirit of harts-horn, or the mere pungent and powerful smell of a spirit of sal-armoniac, which, by a peculiar way, I made very strong, purposely for external uses. And if I had not, out of the experienced *Monardes*, physician to the viceroy of the *Spanish Indies*, already mentioned in another treatise an antiscorbutical gem, I would here add another remedy against the same disease, more considerably to my present purpose, since it is only a simple stone outwardly applied.

See Nicol.
Monard.
Simpl.
Med. Hist.
c. 36. p.
m. 329.

4. BUT, because I think not fit in this place, to insist on a testimony already alledged, though its credibility, as well as that of the thing to be confirmed by it, may be much favoured by what has been related, concerning the virtues of stones outwardly applied, in the latter part of the discourse about specifics: for this reason, I say, I shall add a couple of other remarkable instances, of the efficacy of even dry and solid bodies, though but externally applied in diseases attended with several, and divers of them uncommon symptoms, whereof, whatever many think of the harmlessness of our English vipers, I have here known several instances, in men as well as brutes: And yet in these dangerous cases, many, that come from *East India*, extol the efficacy of some of those stony concretions, that are said to be found in the heads of a certain kind of serpents about *Goa*, and some other Eastern countries: for though most physicians reject or question the power ascribed to these stones, for curing the bitings of vipers; and though I do not wonder at their diffidence, because, in effect, many of the stones brought from *India* are but counterfeit, and of those, that were really taken out of serpents, several, for a reason I must not stay to mention, are insignificant, (and such perhaps were those, that the learned and curious *Redi* made his trials with) yet there are others, whose virtues are not well to be denied. For, not to build on vulgar traditions, which are but too often deceitful, one of the eminentest doctors of the *London* college assured me, that he had, with one of these stones done, though contrary to his expectation, a notable cure, which he related to me at large. And one of our chief English surgeons affirmed to me, that he had done the like upon another person; both of these cures being performed by the bare application of the stone to the place bitten by the viper or adder. And a very intelligent person, who had the direction of a considerable company of traders in *East India*, where he long lived, assured me, that he had

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with this stone, cured several persons of the hurts of venomous animals. But this testimony is much less considerable, as to the number of cures, than that of a great traveller into the Southern parts of the same *India*, who, though he was bred by a famous Cartesian philosopher, and were forward enough to discredit vulgar traditions about the countries he had long lived in; yet being for those reasons asked by me, what I might safely believe of the stones I speak of, seriously affirmed to me, that he had cured above threescore persons of the bitings or stings of several sorts of poisonous creatures; and that he performed most of those cures by the outward application of one stone, because, finding it excellent, he was invited to keep to it, especially in difficult cases. And this same experience of my own made with a genuine stone of this kind, upon the bodies of brutes, much inclines me to give credit to it. But, because this stone is afforded by an animal, I shall add the virtues of another, that properly belongs to the mineral kingdom, in a disease, whose symptoms, though not so various, are sometimes dangerous, and too often mortal.

To shew you then, that in spite of great closeness and hardness, a simple remedy outwardly applied may be a very effectual one, I shall inform you, that though the stone I am speaking of pass for a bloodstone, yet by its colour, and some other visible qualities, I should rather have taken it for an agat. It was but about the bigness of a small nutmeg, and had in it a perforation, by which a string pass through it, to fasten it to the part affected. This stone had been long kept in the family, that possessed it, when I saw it, being, for its rare virtues, left by one to another. But, to omit the reports, that went of it, the notable case, that makes it pertinent for me to mention it here, was this: An ingenious gentleman, that was a man of letters, and, when I saw him, was in the flower of his age, and of a complexion so highly sanguine, as is not usually to be met with, was, from time to time, subject to hæmorrhages at the nose, so profuse and so difficult to be restrained, that his physician, though a person famous, and very well skilled in his art, told me he often feared he should lose his patient, and that he would be carried away by this unbridled distemper. But when good method and variety of remedies had been tried, without the desired success, this stone was at length obtained from an antient kinswoman of the gentleman's, to tie about his neck, so as to touch his naked skin. This when he did in the fits, it would stop the bleeding; and if he wore it for some considerable time together, he all that while continued well, as both his learned physician and himself informed me. And, because I was apt to ascribe somewhat of this effect to imagination, the patient told me, that, a while before, one of the chief women in the city, (whom he named to me) fell into so violent a bleeding, that, though it brought her into a swoon, yet that itself, which is somewhat strange, did not hinder her to bleed on, till the stone, having been tied about her neck, made her cease to do so, though she knew nothing of its having been applied to her. And this itself is less strange, than what the gentleman affirmed to me of the power of this gem, as it may deservedly be called: for his complexion inclining him, as was above intimated, to breed great store of blood, his doctor thought fit to order him, for prevention, to breath a vein from time to time; which when he was about to do, he was obliged to lay aside the stone for a while, because, whilst he kept it on, the blood would not issue out, at least, with the requisite freedom.

BUT how far have I already pass beyond the designed limits of this little tract! wherein I at first intended but to lay before you the five chief advantages, I had observed mere simple remedies to have of very compounded ones; and briefly to propose the main grounds, on which I ascribed those advantages to such remedies. But though the better to keep this writing from being prolix, I designed, that it

should consist of such particulars, as I could best spare from other papers; and though, for that reason, I have purposely omitted many parable, and other but little compounded or elaborate medicines; yet I now perceive, that so many new particulars having offered themselves, on several occasions, whilst I was writing, my pen has slipped into the mention of many more receipts, and historical passages, than were at first intended: but believing the subject to be very useful, and not despairing but that the things delivered on it may not be altogether useless, I dare hope you will pardon such faults, as only my desire of making the parts of this small writing rather serviceable, than methodical, or well proportioned, drew me unawares into. But whatever were the cause of my prolixity, the bulk, which I see this paper has already swelled to, admonishes me, that I ought to put a speedy period to it, without spending time solicitously to declare in what sense I commend the medicines delivered in this invitation. For by recalling to mind what I have formerly wrote (in a treatise you have been pleased to peruse*) about the limitations, with which I would have the praises I give of some remedies understood, and the cautions, with which I would have them administered; you will easily be persuaded, that looking upon them but as fit tools in a skilful workman's hands, I do not pretend, that any of them should do the offices both of physic and physician too; and that I propose not the medicines mentioned in this short paper, as sure specifics, but as instances, that there are remedies, which, notwithstanding their being but simple ones, may be very good ones.

* See the Appendix to the first section of the second part of the *Usefulness of Experimental Philosophy*, p. 389. 390. and of the second edition,

I am, S I R,

Your most, &c.

R. B.

OF THE
HIGH VENERATION
MAN'S INTELLECT owes to GOD,
PECULIARLY FOR
His WISDOM and POWER.

ADVERTISEMENT.

THE abrupt beginning of the following paper will not (it is hoped) be wondered at, when it is declared, that the whole excursion is to be looked upon as a fragment of a discourse, from which, for certain reasons, it has been separated in its present form; in which it ought to pass but for a rough draught, the nobleness, sublimity, and sacredness of the subject, not allowing the author to presume, that the first thoughts he committed to paper about it, might be for good and all parted with by him, till he shall have heedfully revised and corrected them, and left in them as few faults, as the disproportion of so vast and sublime a subject to his slender abilities will permit. The loose sheets this paper consist of having been written at somewhat distant times and places, and hastily tacked together, so that when the latter sheets were penning the former were often not at hand; it is hoped, that if some few things should chance to be either misplaced or repeated, the fault will be thought venial, and be more easily excused, than it could in the author's circumstances be avoided. And lastly, notice is to be given, that those other long passages, that are included in * parentheses, may, with the author's consent (or rather by his desire) be skipped over, being but conjectural thoughts, written and inserted for the sake of a virtuoso, that is a great friend to such kind of adventurous speculations.

* Such figures as these []

Of the High Veneration MAN'S INTELLECT owes
to GOD.

1. **U**PON this occasion I shall take leave to declare, that it is not without some indignation, as well as wonder, that I see many men, and some of them divines too, who little considering what God is, and what themselves are, presume to talk of him and his attributes as freely and as unpremeditatedly, as if they were talking of a geometrical figure, or a mechanical engine: so that even the less presumptuous discourse, as if the nature and perfections of that unparalled Being were objects, that their intellects can grasp: and scruple not to dogmatize about those abstruse subjects, as freely as about other things, that are confessedly within the reach of human reason, or perhaps are to be found among the more familiar objects of sense.

2. THE presumption and inconsiderateness of these men might be manifest by divers considerations, if I had leisure to insist on them; but at present I shall employ but these

these two : first, that it is probable, that God may have divers attributes, and consequently perfections, that are, as yet, unknown to us : and secondly, that of those attributes, that we have already some knowledge of, there are effects and properties, whose sublimity or abstruseness surpassing our comprehension, makes the divine cause, or author of them, deserve our highest wonder and veneration

3. To begin with the first of these : whereas there are two chief ways to arrive at the knowledge of God's attributes ; the contemplation of his works, and the study of his word ; I think it may be doubted, whether either or both of these will suffice to acquaint us with all his perfections.

4. For, first, though philosophers have rationally deduced the power, wisdom and goodness of God, from those impresses of them, that he hath stamped upon divers of his visible works ; yet since the divine attributes, which the creatures point at, are those, whereof themselves have some, though but imperfect, participation, or resemblance ; and since the fecundity (if I may so speak) of the divine nature is such, that its excellencies may be participated or represented in I know not how many ways ; how can we be sure, that so perfect and exuberant a Being may not have excellencies, that it hath not expressed or adumbrated in the visible world, or any parts of it, that are known to us ?

5. This will be the more easily granted, if we consider, that there are some of those divine attributes we do know, which, being relative to the creatures, could scarce, if at all, be discovered by such imperfect intellects as ours, save by the consideration of some things actually done by God. As supposing, that just before the foundations of the visible world were laid, the angels were not more knowing than men now are ; they could scarce think, that there was in God a power of creating matter, (which few, if any at all of *Peripateticks*, *Epicureans*, to omit others of the antient philosophers, seem ever to have dreamed of) and of producing in it local motion ; especially considering the puzzling difficulties, that attend the conception of the very nature and being of the one and of the other : and much less (as far as we can conjecture) could the angels spoken of have known, how the rational soul and human body act upon one another. Whence it seems probable, that if God have made other worlds, or other vortices, than that which we live in, and are surrounded by, (as who can assure us that he hath not ? he may have displayed in some of the creatures, that compose them, divers attributes, that we have not discovered by the help of those works of his, that we are acquainted with. But of this more hereafter.

6. I READILY grant, (that I may proceed now to the second help to acquire the knowledge of the divine attributes) that the revelations God hath vouchsafed us in the holy scriptures (which we owe to that spirit, which *searcheth all things, even τὰ Βάθη τῆς Θεῆς, the depths of God*) have clearly taught us divers things, concerning their adorable Author, which the mere light of nature either would not have shewn us at all, or would have but dimly discovered to us. But the scripture tells us indeed, that the promulgators of the gospel declared to men *the whole counsel of God* (as far as was necessary for their salvation) but never says, that they disclosed to them *the whole nature of God*, who is said to *inhabit an unapproachable light*, which human speculations cannot penetrate. Upon which score perhaps it was, that the Jews would have the proper name of God to be ineffable, to signify, that his nature is incomprehensible. And, though I will not adopt their opinion, yet I cannot but take notice, that it is, at least, no mere Talmudical tradition, since we find not, that either our Saviour himself, or his apostles (who are introduced so frequently making mention of God in the new testament) expressed in speaking either to him, or of him, the *nomen tetragrammaton* (or four-lettered name !) But not to insist on conjectures ; the scripture itself, that brings so much light

1 Cor. ii. 10.

Acts xx. 27.

1 Tim. vi. 16.

1 Cor. xiii. to things divine, that the gospel is called *light*, in the abstract; the scripture, I say, in-
 12. forms us, that in this life *we know but in part, and see things but darkly, as in a glass,*
 Job. xi. 7. and we are so far from being able *to find out God to perfection*, as to his nature and at-
 Rom. xi. 33. tributes, that even the *ways* of his providence are to us *untraceable*.

7. THESE are some of the considerations, that inclined me to think, that God may have attributes, that are not known to us. And this opinion perhaps will appear the more allowable, because of what I am going to add in answer to a weighty objection: for I know it may be alledged, that besides the two ways I have mentioned of attaining to the knowledge of God's attributes, there may be a third way preferable to both the others, and that is, by considering the idea of a Being supremely or infinitely perfect; in which idea it may be alledged, that all possible perfections are contained; so that no new one can be added to it. But though I readily grant, that this idea is the most genuine, that I am able to frame of the Deity, yet there may be divers attributes, which, though they are indeed in a general way contained in this idea, are not in particular discovered to us by it. It is true, that, when by any means whatsoever, any divine perfection comes to our knowledge, we may well conclude, that it is in a sense comprised in the comprehensive notion we have of a Being absolutely perfect; but it is possible, that that perfection would never have come to our knowledge by the bare contemplation of that general idea, but was suggested by particularities; so that such discoveries are not so much derived from, as referred to, the notion we are speaking of.

THE past considerations have, I presume, persuaded you, that God may have, as divers attributes, so divers excellencies and perfections, that are not known to us. It will therefore now be seasonable to endeavour to shew you, that of divers of the attributes, we know that he hath, we men have but an imperfect knowledge, especially in comparison of what he has of them; which is not to be wondered at, since he possesses them in a manner or a degree peculiar to himself, and far transcending that, wherein we men possess them, or rather some faint resemblances of them.

It would be very unsuitable to my intended brevity, and more disproportionate to my small abilities, to attempt the making this good, by insisting particularly on all the divine excellencies, that we are in some measure acquainted with. I therefore hope it may suffice to instance in a couple of the most known ones; God's power and his wisdom. Which two I pitch upon, as being those that men are wont to look on as the principal, and for which they have the greatest admiration and respect, because we are not able to confer them on ourselves, as we think we can divers other virtues and perfections. For every man easily believes, that he may be as chaste, as temperate, as just, and, in a word, as good, as he pleases, those virtues depending on his own will; but he is sensible, that he cannot be as knowing, as wise, and as powerful, as he would; and thence he not irrationally concludes, that power and wisdom flow from, and argue, an excellency and superiority of nature or condition. The power and wisdom of God display themselves by what he does in reference both to his corporeal and his incorporeal creatures.

AMONG the manifold effects of the divine power, my intended brevity will allow me to mention only two or three, which, though to discerning eyes they be very manifest, are not wont to be very attentively reflected on: the immense quantity of corporeal substance, that the divine power provided for the framing of the universe; and the great force of the local motion, that was imparted to it, and is regulated in it.

AND first; the vastness of that huge mass of matter, that the corporeal world consists of, cannot but appear stupendous to those, that skilfully contemplate it. That part of the universe, which has been already discovered by human eyes, assisted with di-
 optical

optical glasses, is almost unconceivably vast; as will be easily granted, if we assent to what the best astronomers, as well modern as antient, scruple not to deliver. The fixt stars of the first magnitude, that to vulgar eyes look but like shining spangles, are by artists affirmed to exceed, each of them, above a hundred times in bigness the whole globe of the earth: and as little as these twinkling stars appear to our naked eyes, they do (which probably you will think strange) appear much lesser through our telescopes, which, taking off those false lights, that make them look to our maimed sight as they are wont to be painted, shew them little otherwise, than as specks or physical points of light. And the sun, which is granted to be some millions of miles nearer to us than the other fixt stars are, though it seems at this lesser distance not to be half a foot broad, is by the generality of mathematicians believed to be above a hundred and threescore times bigger than the earth; nay, according to the more recent calculations of some more accurate modern artists, it is estimated to be eight or ten thousand times as big as the terraqueous globe, and by farther observation may perhaps be found yet much vaster. And it plainly appears by the parallaxes and other proofs, that this globe of earth and water, that we inhabit, and often call the world, though it be divided into so many great empires, and kingdoms, and seas, and though, according to the received opinion, it be 5400 German leagues in circuit, and consequently contain 10,882,080,000 cubic miles in solid measure, and according to the more modern observations have a greater circumference (amounting to above 26,000 miles;) yet this globe, I say, is so far from being, for its bulk, a considerable part of the universe, that without much hyperbole we may say, that it is in comparison thereof but a physical point: nay, those far greater globes of the sun and other fixt stars, and all the solid masses of the world to boot, if they were reduced into one, would perhaps bear a less proportion to the fluid part of the universe, than a nut to the ocean. Which brings into my mind the sentence of an excellent modern astronomer, that the stars of the sky, if they were crouded into one body, and placed where the earth is, would, if that globe were placed at a fit distance, appear to us no bigger, than a star of the first magnitude does. And after all this I must remind you, that I have been hitherto speaking but of that part of the corporeal universe, that has been already seen by us: and therefore, I must add, that as vast as this is, yet all that the eye, even when powerfully promoted by prospective tubes, hath discovered to us, is far from representing the world of so great an extent, as I doubt not but more perfect telescopes hereafter will do. And even then the visible part of the world will be far enough from reaching to the bounds of the universe; to which the Cartesians and some other modern philosophers will not allow men to set any; holding the corporeal world to be (as they love to speak) indefinite, and beyond any bounds assignable by us men.

FROM the vast extent of the universe, I now proceed to consider the stupendous quantity of local motion, that the divine power has given the parts of it, and continually maintains in it. Of this we may make some estimate by considering, with what velocity some of the greater bodies themselves are moved; and how great a part of the remaining bodies of the universe is also, though in a somewhat differing way, indowed with motion.

As for the first of these; the least velocity, that I shall mention, is that, which is afforded by the Copernican hypothesis; since, according to that, it is the earth that moves from West to East about its own axis, (for its other motions concern not this discourse) in four and twenty hours. And yet this terraqueous globe, which we think so great, that we commonly call it the world, and which, as was lately noted, by the recenter computations of mathematicians is concluded to contain six or seven and twenty thousand miles in circuit; some part of this globe, I say, moves at such a rate, that the learned *Gassendus* confesses, that a point or place, situated in the æquator of the earth,

earth, does in a second minute move about two hundred toises or fathoms; that is, twelve hundred feet; so that a bullet, when shot out of a cannon, scarce flies with so great a celerity.

9. But, as I was saying, the motion of the earth is the least swift, that I had to mention; being indeed scarce comparable to the velocity of the fixt stars, if, with the generality of astronomers, we suppose them to move in four and twenty hours about the earth. For supposing the distance assigned by the famous *Tycho* (a more accurate observer than his predecessors) between us and the firmament to be fourteen thousand semi-diameters of the earth, a fixt star in the æquator does, as *Mullerius* calculates it, move 3,153,333 miles in an hour, and consequently in a minute of an hour, fifty two thousand five hundred fifty-five miles, and in a second (which is reckoned to be near about a single pulsation or stroke of the artery of a healthy man) 875 miles; which is about, if not above, three thousand times faster, than a cannon bullet moves in the air. It is true, that according to the Ptolomean hypothesis, a fixt star in the equinoctial doth in a second move at most but three semi-diameters of the earth: but according to the learned and diligent *Ricciolus*, this velocity (of our fixt stars) is fifty times greater than in the Ptolomean hypothesis, and threescore and ten times greater than in the Tychonian hypothesis; for according to *Ricciolus*, such a fixt star as we speak of, moves in a second minute (or one beating of the pulse) 157282 German leagues, which amount to six hundred twenty-nine thousand one hundred twenty-eight English miles.

See Ricciol.
Al. mag.
nov. Lib.
ix.
Sect. iv.
Cap. vi.

AND now I shall add (what possibly you have not observed) that that portion of the universe, which commonly passes for *quiescent*, and yet has motion put into it, is so great, that, for aught I know, the quantity of motion distributed among these seemingly quiescent bodies, may equal, if not exceed, the quantity of motion, the first mover has communicated to the fixt stars themselves, though we suppose them whirled about the earth with that stupendous swiftness, that the Ptolemeans and Tychonians attribute to them. For I reckon, that the fixt stars and planets, or, if you please, all the mundane globes, whether lucid or opacous, of which last sort is the earth, do all of them together bear but a small proportion to the interstellar part of the universe. And though I should allow all these globes to be solid, notwithstanding that it can scarce be proved of any of them; and the Cartesians think the sun (which they take to be a fixt star, and therefore probably of the same nature with the rest) to be extremely fluid: though I should, I say, grant this, yet it must be confessed, that each of these solid globes swims in an ambient fluid of very much greater extent, than itself is: so that the fluid portion of the universe will in bulk almost incomparably exceed the solid. And if we consider, what is the nature of a fluid body, as such, we shall find, that it consists in having its minute parts perpetually and variously moved, some this way and some that way; so that though the whole body of a liquor seems to be at rest, yet the minute parts, that compose that liquor, are in a restless motion, continually shifting places amongst themselves, as has been amply shewn in a late tract, intituled, the *history of fluidity and firmness*.

10. AND because the quantity of motion shared by the corpuscles, that compose fluid bodies, is not usually reflected on even by philosophers, it will not be here amiss to add, that how great and vehement a motion the parts of fluid bodies (perhaps when the aggregates of those particles appear quiescent) may be endowed with, we may be assisted to guess, by observing them, when their ordinary motions happen to be disturbed, or to be extraordinarily excited by fit conjectures of circumstances. This may be observed in the strange force and effects of boisterous winds and whirlwinds, which yet are but streams and whirlpools of the invisible air, whose singly insensible parts are by

by accidental causes determined to have their motion made either in a straight or almost straight line, or, as it were, about a common centre: but an instance, much more conspicuous, may be afforded by a mine charged with gunpowder, where the flame, or some subtile æthereal substance, that is always at hand in the air, though both one and the other of them be a fluid body, and the powder perhaps be kindled but by one spark of fire, exerts a motion so rapid and furious, as in a trice is able to toss up into the air whole houses and thick walls, together with the firm soil, or perchance solid rocks, they were built upon.

11. BUT since the velocity of these discharged flames may be guessed at by that, which the flame of gunpowder impresses on a bullet shot out of a well charged gun, which the diligent *Mersennus*, who made several trials to measure it, defines to be about 75 toises, or fathoms (that is, 450 foot) in a second, being the 60th part of a minute; if we admit the probable opinion of the Cartesians, that the earth and divers other mundane globes, as the planets, are turned about their own axes by the motion of the respective æthereal vortices or whirlpools, in which they swim, we shall easily grant, that the motion of the celestial matter, that moves, for instance, upon the remote confines of the earth's vortex, is by a vast excess more rapid, than that of the surface of the earth: and yet we formerly observed, that a place situated under the æquator does (if the earth turns about its own axis) move as swiftly as a bullet shot out of a cannon. But if we chuse rather the Tychonian hypothesis, which makes the firmament, with all the vast globes of light that adorn it, to move about their common centre in 24 hours, the motions of the celestial matter must be allowed a far greater, and indeed a scarce imaginable rapidity.

THESE things are mentioned, that we may have the more enlarged conceptions of the power as well as wisdom of the great creator, who has both put so wonderful a quantity of motion into the universal matter and maintains it therein, and is able, not only to set bounds to the raging sea, and effectually say to it, hitherto shalt thou come, and no farther, and here shall thy proud waves be stay'd, but, (what is far more) so to curb and moderate those stupendously rapid motions of the mundane globes and intercurrent fluids, that neither the unwieldiness of their bulk, nor celerity of their motions, have made them exorbitate or fly out, and this for many ages; during which no watch for a few hours has gone so regularly; the sun, for instance, moving, without swerving, under the same circular line, that is called the ecliptick. And if the firmament itself, whose motion in the vulgar hypothesis is by much the most rapid in the world, do fail of exactly completing its revolution in 24 hours, that retardation is so regulated, that since *Hipparchus's* time, who lived 2000 years ago, the first star in Aries, which was then near the beginning of it, is not yet come to the last degree of that sign.

12. AFTER what hath been discoursed of the power of God, it remains, that I say something about his wisdom; that being the attribute, to which those, that have elevated understandings, are wont to pay the highest veneration, when they meet it even in men, where yet it is still but very imperfect.

THE wisdom of God which saint *Paul* somewhere justly styles πολυποίκιλος *mani-Eph. iii.* fold or multifarious, is expressed in two differing manners or degrees. For some-^{10.} times it is so manifestly displayed in familiar objects, that even superficial and almost careless spectators may take notice of it. But there are many other things, wherein *Col. ii. 3.* the treasures of wisdom and knowledge may be said to be hid; lying so deep, that they require an intelligent and attentive considerer to discover them. But though I think I may be allowed to make this distinction, yet I shall not solicitously confine myself.

myself to it; because in several things both these expressions of the divine wisdom may be clearly observed.

THOSE objects of this wisdom, that we shall at this time consider, are of two sorts; the material and visible, and the invisible and immaterial creatures of God.

IN the first of these, whose aggregate or collection makes up the corporeal world, commonly called universe, I shall briefly take notice of the excellent contrivance of particular bodies; of the great variety, and consequently number, of them; of their symmetry, as they are parts of the world; and of the connexion and dependance they have in relation to one another. And though under the two first of these heads I might, as well as under the other two, take notice of many inanimate bodies as well as of those, that are endowed with vegetative and sensitive souls, (as naturalists commonly call them;) yet, for brevity's sake, I shall here take notice only of that more perfect sort of living creatures, that we call animals.

13. I. THE contrivance of every animal, and especially of a human body, is so curious and exquisite, that it is almost impossible for any body, that has not seen a dissection well made and anatomically considered, to imagine or conceive, how much excellent workmanship is displayed in that admirable engine. But of this having discoursed elsewhere more fully, I shall here only tell you in a word (and it is no hyperbole) that as St. Paul said on another occasion, *that the foolish things of God are wiser than men, and the weak things of God stronger than men*; so we may say, that the meanest living creatures of God's making are far more wisely contrived, than the most excellent pieces of workmanship, that human heads and hands can boast of; and no watch nor clock in the world is any way comparable, for exquisiteness of mechanism, to the body of even an ass or a frog.

1 Cor. i.
25.

14. II. BUT God's wisdom is recommended as well by the variety, and consequently the number of the kinds of living creatures, as by the fabrick of each of them in particular. For the skill of human architects and other artists is very narrow, and for the most part limited to one or to a few sorts of contrivements. Thus many an architect can build an house well, that cannot build a ship; and (as we daily see) a man may be an excellent clock-maker, that could not make a good watch, and much less contrive well a fowling-piece, or a wind-mill.

15. BUT now the great author of nature has not only created four principal sorts of living engines, namely beasts, birds, fishes, and reptiles, which differ exceedingly from one another, as the several regions or stages, where they were to act their parts, required they should do; but under each of these comprehensive genders are comprized I know not how many subordinate species of animals, that differ exceedingly from others of the same kind, according to the exigency of their particular natures. For not only the fabrick of a beast (as a lion) is very differing from that of a bird, or a fish, (as an eagle or a whale;) but in the same species the structure or mechanism of particular animals is very unlike: witness the difference between the parts of those beasts, that chew the cud, and those that do not; and between the hog and the hare, especially in their entrails; and so between a parrot and a batt, and likewise between a whale, a star-fish, a lobster, and an oyster, (to mention now no other instances.) And if with divers philosophers both ancient and modern we admit vegetables into the rank of living creatures, the number of these being so great, that above six thousand kinds of vegetables were many years ago reckoned up; the manifold displays of the divine mechanism, and so of its wisdom, will by that great variety of living engines be so much the more conspicuous.

16. III. THAT, which much enhances the excellent contrivances to be met with in these automata, is the symmetry of all the various parts, that each of them consists

sists of. For an animal, though, considered in his state of intireness, he is justly looked upon as one engine; yet really this total machine (if I may so call it) is a complex thing made up of several parts, which, considered separately, may pass each of them for a subordinate engine excellently fitted for this or that particular use: as an eye is an admirable optical instrument to enable a man to see; and the hand is so well framed for a multitude of mechanical uses, that *Aristotle* thought fit to call it the organ of organs, (or instrument of instruments.) It ought therefore highly to recommend the wisdom of the great *yotser hakkol*, *former of all things* (as the scripture stiles him,) that he has so framed each particular part of a man (or other animal) as not to let the skill bestowed on that hinder him from making that part or member itself, and every other, neither bigger nor less, nor (in a word) otherwise constituted, than was most expedient for the completeness and welfare of the whole animal. Which manifests, that this great artist had the whole fabrick under his eye at once, and did at one view behold all, that was best to be done, in order to the completeness of the whole animal, as well as to that of each member and other part, and admirably provided for them both at once. Whereas many an excellent artificer, that is able to make a single engine very complete, may not be able to make it a commodious part of a complex or aggregate of engines: as it is not every one, that can make a good pump, that can make a good ship-pump; nor every chymist, that can build an oven for a bakehouse, that can make one fit to be set up in a ship: and we see, that our pendulum clocks, that are moved with weights, and go very regularly a-shore, cannot yet be brought to perform their office (of constantly measuring of time) when set up in a sailing ship.

17. IV. THE fourth way, by which God manifests his wisdom in his corporeal creatures, is, their mutual usefulness to one another, in a relation either of dependency or of co-ordination. This serviceableness may be considered, either as the parts of the animal have a relation to one another, and to the whole body they make up; or as intire and distinct bodies have reference to or dependency on each other. To the first sort of utility belong the uses of the parts of the human body, for instance, which are so framed, that besides these publick offices or functions, that some of them exercise for the good of the whole, as the stomach for concocting aliments, the brain for supplying animal spirits to move the limbs, and other parts, the kidneys to separate the superfluous serum of the blood; there are many other particular parts, that have that subserviency to one another, that no despicable portion of the books of anatomy is employed in the mention of them. And divers consents of parts and utilities, that accrue from one to the other, are farther discovered by diseases, which primarily affecting one part or member of the body, discover that this or that other part has a dependence on it, or a particular relation to it, though perhaps not formerly taken notice of. To the second part of utility belong those parts, that discriminate the sexes of animals, which (parts) have such a relation one to another in the male and the female, that it is obvious they were made for the conjunction of both in order to the propagation of the species. I cannot here spend time to consider the fitness of the distance and situation of the sun, the obliquity of its motion under the ecliptick, and (especially) the compensations, that nature makes by one thing for another, the excess of whose qualities would else be noxious to men, as the great heats and dryness, that reign in many parts of the torrid zone and some neighbouring climates, would render those countries barren and uninhabitable, as the ancients thought them, if they were not kept from being so, by the Etesians and the trade-winds, which blow regularly (though not always the same way) for a great part of the hottest seasons of the year, and are assisted by the length

of the nights, by the copious and lasting rains, that fall at set times, by the greatness of the rivers, (some of them periodically overflowing their banks to great distances) and by the winds, that in many places blow in the night from the land seaward, and in the morning from the sea towards the land; for these, and some other such things, do so moisten and refresh the ground, and temperate the air, that in many of those climates, which the ancients thought parched up and uninhabitable, there are large kingdoms and provinces, that are both fruitful and populous; and divers of them very pleasant too. But, as I was saying, I cannot stay to prosecute what might be represented to shew the usefulness of many of God's other sensible works to the noblest kind of them, men. But I shall rather content myself, by adding a few lines, to point farther at the reference, that God has been pleased to make many other things have to the welfare of men and other animals; as we see, that, according to the usual course of nature, lambs, kids, and many other living creatures, are brought into the world at the spring of the year, when tender grass and other nutritive plants are provided for their food. And the like may be observed in the production of silk-worms, whose eggs, according to nature's institution, are hatched, when mulberry trees begin to bud and put forth those leaves, whereon these precious insects are to feed; the aliments being tender, whilst the worms themselves are so, and growing more strong and substantial, as the insects increase in vigour and bulk.

18. THERE is one thing, which though it might perhaps have been more properly brought in before, must not here be pretermitted. For besides what was lately said of the excellent fabrick of the bodies of men and other animals, we may deservedly take notice, how much more wonderful, than the structure of the grown body, must be the contrivance of a *semen animatum*; since all the future parts, (solid as well as soft) and the functions, and many of the actions (and those to be variable *pro re nata*) of the animal to be produced, must be durably delineated, and, as it were, couched in a little portion of matter, that seems homogeneous, and is unquestionably fluid: and that, which much increases the wonder, is, that one of these latent impressions or powers, namely, the plastick, or prolifick, is to lye dormant perhaps above thirty or forty years, and then to be able to produce many more such engines as is the animal itself.

What is included in Crochets, may be skipped.

[I HAVE hitherto, among the corporeal works of God, taken notice only of those productions of his power and wisdom, that may be observed in the visible world: so that I may be allowed to consider farther, that not only the Peripateticks, but the generality of other philosophers, believe the world to be finite; and, though the Cartesians will not say it is so, but chuse rather to call it indefinite, yet as it is elsewhere shewn, their opinion is rather a well-meant piece of modesty, than a strict truth. For, in reality, the world must every way have bounds, and consequently be finite; or it must not have bounds, and so be truly boundless; or, (which is the same thing in other terms) infinite: and if the world be bounded, then those, that believe a Deity, to whose nature it belongs to be of infinite power, must not deny, that God is, and still was, able to make other worlds than this of ours. And the Epicureans, who admitted no omnipotent Maker of the world, but substituted chance and atoms in his stead, taught, that by reason the causes sufficient to make a world, that is atoms and space, were not wanting, chance has actually made many worlds, of which ours is but one; and the Cartesians must, according to their doctrine of the indefiniteness of corporeal substance, admit, that our visible world, or, if they please, vortex, by which I mean the greatest extent our eyes can reach to, is but a part, and comparatively but a very small one too, of the whole universe, which may

may extend beyond the utmost stars we can see, incomparably farther than those remotest visible bounds are distant from earth.]

Now if we grant, with some modern philosophers, that God has made other worlds besides this of ours, it will be highly probable, that he has there displayed his manifold wisdom, in productions very differing from those, wherein we here admire it. And even, without supposing any more than one universe, as all that portion of it that is visible to us, makes but a part of that vastly extended aggregate of bodies; so if we but suppose, that some of the celestial globes, whether visible to us, or placed beyond the reach of our sight, are peculiar systems, the consideration will not be very different: for since the fixed stars are many of them incomparably more remote than the planets, it is not absurd to suppose, that as the sun, who is the fixed star nearest to us, has a whole system of planets, that move about him; so some of the other fixed stars may be each of them the centre, as it were, of another system of celestial globes; since we see, that some planets themselves, that are determined, by astronomers to be much inferior in bigness to those fixed stars I was speaking of, have other globes, that do, as it were, depend on them, and move about them; as, not to mention the earth, that has the moon for its attendant, nor Saturn, that is not altogether unaccompanied, it is plain, that Jupiter has no less than four satellites, that run their courses about him. And it is not to be pretermitted, that none of these lesser and secondary planets, (if I may so call them) that move about Saturn and Jupiter, are visible to the naked eye, and therefore they were all unknown to the antient astronomers, who lived before the invention of telescopes. Now, in case there be other mundane systems (if I may so speak) besides this visible one of ours, I think it may be probably supposed, that God may have given peculiar and admirable instances of his inexhausted wisdom in the contrivance and government of systems, that, for aught we know, may be framed and managed in a manner quite differing from what is observed in that part of the universe, that is known to us. For, besides that here on earth, the loadstone is a mineral so differing in divers affections, not only from all other stones, but from all other bodies, that are not magnetical, that this heteroclite mineral scarce seems to be originary of this world of ours, but to have come into it by a remove from some other world or system; I remember, that some of the navigators, that discovered *America*, took notice, that at their first coming into some parts of it, though they found great store of animals and plants, yet they met with few of the latter, and scarce any of the former, of the same species with the living creatures of *Europe*.

19. Now in these other worlds, besides that we may suppose, that the original fabric, or that frame, into which the omniscient architect at first contrived the parts of their matter, was very differing from the structure of our system; besides this, I say, we may conceive, that there may be a vast difference betwixt the subsequent phænomena, and productions observable in one of those systems, from what regularly happens in ours, though we should suppose no more, than that two or three laws of local motion may be differing in those unknown worlds from the laws, that obtain in ours. For if we suppose, for instance, that every entire body, whether simple or compounded, great or small, retains always a motive power, (as philosophers commonly think, that the soul does, when it has moved the human body, and as the Epicureans, and many other philosophers, think all atoms do, after they have impelled one another) this power of exciting motion in another body, without the movent's losing its own, will appear of such moment to those, that duly consider, that local motion is the first and chiefest of the second causes, that produce the phænomena of nature, that they will easily grant, that these phænomena must be

strangely diversified, by springing from principal causes so very differing qualified. Nor (to add another way of varying motion) is it absurd to conceive, that God may have created some parts of matter to be of themselves quiescent, (as the Cartesians and divers other philosophers suppose all matter to be in its own nature,) and determined to continue at rest, till some outward agent force it into motion; and yet that he may have endowed other parts of the matter with a power like that, which the atomists ascribe to their principles, of restlessly moving themselves, without losing that power by the motion they excite in quiescent bodies. And the laws of this propagation of motion among bodies may be not the same with those, that are established in our world; so that but one half, or some lesser part, (as a third) of the motion, that is here communicated from a body of such a bulk and velocity, to another it finds at rest, or slower moved than itself, shall there pass from a movent to the body it impels, though all circumstances, except the laws of motion, be supposed to be the same. Nor is it so extravagant a thing, as at first it may seem, to entertain such suspicions as these; for in the common philosophy, besides that the notion and theory of local motion are but very imperfectly proposed, there are laws or rules of it well, not to say at all, established.

20. AND as for the Cartesian laws of motion, though I know they are received by many learned men, yet I suspect, that it is rather upon the authority of so famous a mathematician as *Des Cartes*, than any convictive evidence, that accompanies the rules themselves; since to me (for reasons, that belong not to this discourse) some of them appear not to be befriended either by clear experience, or any cogent reason. And for the rule, that is the most useful, namely, that which asserts, that there is always the same quantity of motion in the world, every body, that moves another, losing just as much of its own, as it produces in the other: the proof he offers, being drawn from the immutability of God, seems very metaphysical, and not very cogent to me, who fear, that the properties and extent of the divine immutability are not so well known to us mortals, as to allow *Cartesius* to make it, in our present case, an argument, *à priori*. And *à posteriori*, I see not, how the rule will be demonstrated; since, besides that it may be questioned, whether it is agreeable to experience in divers instances, that might be given of communicated motions here below; I know not what experience we have of the rules, by which motion is propagated in the heavenly regions of the world, among all the bodies, that make up the ætherial, (which is incomparably the greatest) part of the universe. So that the truth of the Cartesian rules being evinced neither *à priori*, nor *à posteriori*, it appears not, why it should be thought unreasonable to imagine, that other systems may have some peculiar laws of motion; only because they differ from those Cartesian rules, whereof the greatest part are, at least, undemonstrated.]

21. BUT though, if we allow of suppositions and conjectures, such as those lately mentioned, that are, at least, not absurd, they may conduce to amplify some of our ideas of divine things; yet we need not fly to imaginary ultra-mundane spaces, to be convinced, that the effects of the power and wisdom of God are worthy of their causes, and not near adequately understood by us, if with sufficient attention, we consider that innumerable multitude, and unspeakable variety of bodies, that make up this vast universe. For, there being among these a stupendous number, that may justly be looked upon as so many distinct engines, and many of them very complicated ones too, as containing sundry subordinate ones; to know, that all these, as well as the rest of the mundane matter, are every moment sustained, guided and governed, according to their respective natures, and with an exact regard to the catholic laws of the universe; to know, I say, that there is a Being, that doth this every where, and every

every moment, and that manages all things, without either aberration or intermission, is a thing that, if we attentively reflect on, ought to produce in us for that supreme Being, that can do this, the highest wonder, and the lowliest adoration.

THE Epicureans of old did, with some colour of reason, as well as with much confidence, urge against the belief of a divine Providence, that it is unconceivable, and therefore incredible, that the gods should be sufficient for such differing and distracting employments, as, according to the exigencies of Nature's works, to make the sun shine in one place, the rain shower down in another, the winds to blow in a third, the lightening to flash in a fourth, the thunderbolts to fall in a fifth; and, in short, other bodies to act and suffer, according to their respective natures. Wherefore we, that, upon good grounds believe, that God really does, what these philosophers thought impossible to be done by any agents whatsoever, are much wanting in our duty, if we do not admire an all-pervading wisdom, that reaches to the utmost extent of the universe, and actually performing what philosophers professed they could not so much as conceive, highly merits, that those difficulties, which they thought insuperable, and so a sufficient excuse for their unbelief, should be a powerful motive to our veneration of that transcendent wisdom, that without any trouble surmounts them.

22. WE have seen some displays of God's wisdom as well as power by what we have observed, in his corporeal works: but it will be easily granted, that some of the divine perfections could not be so well expressed, or copied upon corporeal creatures, as upon the rational and immaterial soul of man, and other intellectual beings; as the picture of an apple or a cherry, or the character of a number, is not capable of receiving or containing so much of an excellent painter's skill, as he may exhibit in a piece, wherein the passions of the mind, and the laws of opticks, and of decency, may be fully expressed. And, it may be well presumed, that if we were as familiarly acquainted with God's incorporeal creatures, as we are with his visible ones, we should perceive, that as spirits are incomparably more noble than bodies, so the Divine Wisdom, employed in the government and conduct of them, is more glorious than that, which we justly admire in the frame and management of his corporeal works. And indeed, let a portion of matter be never so fine, and never so well contrived, it will not be any more than an engine devoid of intellect and will, truly so called, and whose excellency, as well as its distinction from other bodies, even the grossest and imperfectest, can consist but in mechanical affections, such as the size, shape, motion and connexion of its parts; which can neither excite themselves into motion, nor regulate and stop the motion they once are in: whereas true spirits (by which I here mean immaterial substances) have, by God's appointment, belonging to their nature, understanding, will, and an internal principle, both of acting so and so, and of arbitrarily ceasing from action. And though God, as the sole creator of all substances, has, and, if he please, may exercise an absolute dominion over all his creatures, as well immaterial as corporeal; yet since he has thought fit to govern spirits according to the nature he has given them, (which comprehends both understanding and will) to create such intelligent, free and powerful beings, as good and bad angels, (to say nothing now of men) and to govern them on those terms, so as effectually to make them (however they behave themselves) instruments of his glory, which multitudes of them do as subtly, as obstinately oppose; to do these things, I say, requires a wisdom and providence transcending any, that can be displayed in the formation and management of merely corporeal beings: for inanimate engines may be so contrived, as to act but as we please; whereas angels and human souls are endowed with a freedom of acting, in most cases, as themselves please.

please. And it is far easier for a skilful watch-maker to regulate the motions of his watch, than the affections and actions of his son.

23. AND here give me leave to consider, that angels, whether good or bad, are very intelligent and active beings; and that each of them is endowed with an intellect capable of almost innumerable notions and degrees, or variations of knowledge, and also with a will, capable of no less numerous exertions or acts; and of having various influences upon the understanding, as (on the other side) it is variously affected by the dictates of it: so that (to apply this consideration to my present purpose) each particular angel being successively capable of so many differing moral states, may be looked upon, as, in a manner, a distinct species of the intellectual kind: and the government of one dæmon, may be as difficult a work, and consequently may as much declare the wisdom and power of God, as the government of a whole species of inanimate bodies, such as stones or metals, whose nature determines them to a strict conformity to those primordial laws of motion, which were once settled by the Great Creator, and from which they have no wills of their own to make them swerve.

THE scripture tells us, that in the œconomy of man's salvation there is so much of the manifold wisdom of God expressed, that the angels themselves desire to pry into those mysteries. When our Saviour having told his apostles, that the day and hour of his future coming to judgment (whether of the Jewish nation or the world, I now inquire not) was not then known to any, subjoins, *no, not to the angels of heaven, but to his Father only*: he sufficiently intimates them to be endowed with excellent knowledge, superior to that of men; and that perhaps may be one of the reasons, why the scripture styles them angels of light. It also teaches us, that the good angels are vastly numerous, and that as they are of differing orders, some of them being arch-angels, and some princes of particular empires or nations; so God assigns them very differing and important employments both in heaven and in earth; and sometimes such as oblige them, in discharge of their respective trusts, to endeavour the carrying on of interfering designs. The same scripture by speaking of the devil and his angels, and of the great dragon, that drew down with his tail the third part of the stars from heaven to earth, and by mentioning a whole legion of devils, that possessed a single man, and by divers other passages, that I shall not now insist on, giving us ground to conclude, that there is a political government in the kingdom of darkness; that the monarch of it is exceeding powerful, whence he is styled the prince of this world, and some of his officers have the titles of principalities, powers, rulers of the darkness of this world, &c. that the subjects of it are exceeding numerous; that they are desperate enemies to God and men, whence the devil is styled the adversary, the tempter, and a murderer from the beginning; that they are very false and crafty, whence the devil is called the *father of lies*, the *old serpent*; and his stratagems are styled the *wiles*, and *depths of Satan*; that their malice is as active and restless, as it is great, whence we are told, that our adversary the devil, *walks about like a roaring lion, seeking whom he may devour*. These things being taught us in the scripture itself, though I shall not now add any of the inferences that may be drawn from them to my present purpose, we may rationally suppose, that if we were quick-sighted enough to discern the methods of the divine wisdom in the government of the angelical and of the diabolical worlds, or great communities, if I may so call them; we should be ravished into admiration, how such intelligent, free, powerful, and immortal agents, should be, without violence offered to their nature, made in various manners to conspire to fulfil the laws, or at least accomplish the ends, of that great theocracy, that does not alone reach to all kinds of bodies, to men, and to this or that rank of spirits, but comprises the whole creation, or the great aggregate of all the creatures of God. And indeed to make the voluntary, and per-

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Mat. xxiv.
36.

Eph. vi.
12.

1 Pet. v. 8.

haps the most crafty actions of evil men, and of evil spirits themselves, subservient to his wise and just ends, does no less recommend the wisdom of God, than it would the skill of a ship-wright and pilot, if he was able to contrive and steer his ship so, as to sail to his designed port, not only with a side-wind, or very near a wind, as many do; but with a quite contrary wind, and that a tempestuous one too.

24. PERHAPS you will think it allowable, that on this occasion I antedate, what in due time will infallibly come to pass; and now briefly take some notice, as if it were present, of the diffused and illustrious manifestation of the divine wisdom, (as well as justice and mercy,) that will gloriously appear at the day of the general judgment, when every good Christian's eyes shall be vouchsafed a much larger prospect, than that, which his Saviour himself had, when he surveyed in a trice, and, as it were, at one view, *all the kingdoms of the world*; and shall behold a much more numerous (not to say numberless) assembly, than that, which is said to have consisted of *all people, nations and languages*, that flocked in to the dedication of *Nebuchadnezzar's golden image*. Luke iv. 5.
Dan. iii.

At that great decreitory day, when the whole off-spring of *Adam* shall, by the loud voice and trumpet of the arch-angel, be called together from the remotest ages and the distantest climates in the world: when, I say, besides the fallen angels, all the human actors, that ever lived, shall appear upon the stage at once; *when the dead shall be raised, and the books shall be opened*, (that is, the records of heaven and of con- Rev. xx.
12. science;) then the wisdom of God will shine forth in its meridian lustre, and its full splendor. Not only the occurrences, that relate to the lives and actions of particular persons, or of private families, and other lesser societies of men, will be there found not to have been overlooked by the divine providence; but the fates of kingdoms and commonwealths, and the revolutions of nations and of empires, will appear to have been ordered and over-ruled by an incomparable wisdom: and those great politicians, that thought to out-wit providence by their refined subtilties, shall find themselves taken in their own craftiness, shall have their deepest counsels turned into foolishness, and shall not be able to keep the amazed world from discovering, that whilst they thought they most craftily pursued their own ends, they really accomplished God's: and those subtle hypocrites, that thought to make pretended religion the instrument of their secular designs, shall find those designs both defeated, and made truly subservient to that advancement of religion, which they really never aimed at.

25. To employ and keep in order a very complicated engine, such as the famous *Strasburgh clock*, or a man of war, though all the parts of it be inanimate and devoid of purposes and ends of their own, is justly counted a piece of skill; and this task is more difficult, and consequently does recommend the conduct of the performer, in proportion to the intricate structure, and the number of pieces, whereof the engine consists: at which rate, how astonishing and ravishing will appear that wisdom and providence, that is able to guide and over-rule many thousand millions of engines endowed with wills, so as to make them all be found, in the final issue of things, subservient to purposes worthy of divine providence, holiness, justice and goodness.

In short, when all the actors, that had their parts in this world, shall appear at once upon the stage, when all disguises shall be stript off, all intrigues discovered, all hearts and designs laid open; then to find, that this whole amazing opera, that has been acting upon the face of the earth, from the beginning to the end of time, has been so contrived and carried on by the great author of the world and of men, that their innumerable various actions and cross designs are brought, (commonly with-

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out, and often against their wills,) to conspire to the accomplishment of a plot worthy of God, will appear an effect of so vast and so all-pervading a wisdom, as human intellects will admiringly confess, that nothing but a divine and omniscient one could compass.

26. IT is like you may have taken notice, that among the several instances I have given of the wisdom of God, I have not, (unless perhaps incidentally and transiently,) mentioned the oeconomy of man's salvation by *Jesus Christ*: and therefore I think myself obliged to advertise you, that though, for reasons to be given you, if you desire it, by word of mouth, I have thought fit that subject, which has been already handled by so many professed divines, should be left untreated of by me, who am a layman; yet I did not pretermitt it, upon the score of thinking it at all inferior to those other manifestations of God's wisdom, that I expressly discourse of.

1 Tim.
iii. 16.

FOR I think, that in the redemption of mankind more of the divine attributes, than are commonly taken notice of, have their distinct agencies; and that their co-operation is so admirably directed by the divine wisdom, that an apostle may very justly call it the *great mystery of godliness*; and that it no less deserves our wonder than our gratitude.

Be 6n 78
Oes
1 Cor. ii.
10. ii. 7.

27. I AM not ignorant, that many learned divines have largely, and some of them laudably treated of this subject. But I confess I doubt whether most of them have not been more happy in their care to avoid errors about it, than skilful in their attempts to unveil the mysteries couched in it. There are in the great work of man's redemption some characters and footsteps of the divine wisdom, so conspicuous, not to say so resplendent, that a believer endowed but with a mediocrity of parts may easily enough discern them; but there are also in this sublime and comprehensive work some *depths of God*, (to use a scripture phrase) and so much of the *wisdom of God in a mystery*, (that is, of the mysterious wisdom of God) that I cannot think it an easy matter to have a mental eye so enlightened and so piercing, as to treat largely and worthily of so vast and abstruse a subject. And indeed when I consider, that a man must know much of the nature of spirits in general, and even of the father of them God himself; of the intellect, will, &c. of the soul of man; of the state of *Adam* in paradise, and after his fall; of the influence of his fall upon his posterity, of the natural or arbitrary vindictive justice of God; of the grounds and ends of God's inflicting punishments, as a creditor, a ruler, or both; of the admirable and unparalleled person of *Christ* the mediator; of those qualifications and offices, that are required to fit him for being lapsed man's redeemer; of the nature of covenants, and the conditions of those God vouchsafed to make with man, whether of works, or grace; of the divine decrees, in reference to man's final state; of the secret and powerful operations of grace upon the mind, and the manner, by which the spirit of God works upon the souls of men, that he converts, and brings by sanctification to glory: to be short, there are so many points (for I have left divers unnamed) most of them of difficult speculation, that are fit to be discussed by him, that would solidly and fully treat of the world's redemption by *Jesus Christ*, that when I reflect on them, I am ready to exclaim with *St. Paul*, *who is sufficient for these things?* and I am so far from wondering, that the generality of divines, and other writers on this subject, have not fully displayed the wisdom, that God has expressed in this great work, that to have been able to accomplish it in so admirable a way, as God has actually contrived and made choice of, is one of the chief reasons of my admiration of the wisdom itself. And I am persuaded, that for God to reconcile his inflexible justice, his exuberant mercy, and all those other things, that seemed to clash inevitably about the de-

signed salvation of men, and make them co-operate to it, is a stupendous manifestation of wisdom; there being no problem in *Diophantus*, *Alexandrinus*, or *Apollonius Pergæus*, in algebra, or in geometry, near so difficult to be solved, or that requires, that a greater number of proportions and congruities should be attended to at once, and made subservient to the same ends, as that great problem propounded by God's infinite goodness to his divine wisdom; *the redemption of lost and perverse mankind, upon the terms declared in the gospel*, which are admirably fitted to promote at once God's glory and man's felicity.

28. THOUGH what has been said of the greatness of God's power and wisdom, may justly persuade us, that those attributes are divine and adorable; yet I must not deny, that the representation, that I have made of them, is upon several accounts very disadvantageous. For first, there has not been said of them in this paper all, that even I could have mentioned, to set forth their excellency; because I had elsewhere treated of that subject, and was more willing to present you with some things I had not said before, than trouble you with many repetitions: but if, instead of so unfit a person as I, the manifestation of the divine wisdom had been undertaken by the knowingest man in the world, or perhaps even by an angel, he would find himself unable fully to make out the matchless excellency of it. For how much wisdom has been exercised by an omniscient being, cannot be fully comprehended, or consequently described, but by an infinite understanding: besides, I have considered the wisdom displayed by God in the works of his creation and providence, with respect to them, not to us; for they are excellent, absolutely, and in their own nature, and would simply upon that account deserve the wonder and the praises of rational beings, as they are rational; as *Xeuxes* justly celebrated the skill of *Apelles*, and modern geometers and mechanicians admire *Archimedes*. But in this irrelative contemplation of God's works, a man's mind being intent only upon the excellencies he discovers in them, he is not near so much affected with a just sense of the inferiority of his to the divine intellect, as he would be, if he heedfully consider, how much of the vast subjects he contemplates are undiscovered by him, and how dim and imperfect the knowledge is, which he has of that little he does discover. And now, lastly, to the other disadvantages, with which I have been reduced to represent (and so to blemish) the divine attributes, I must add, that I have insisted but upon two of them, God's power and his wisdom; whereas we know, that he has divers other perfections, as (besides those incommunicable ones, his self-experience, self-sufficiency, and independency) his goodness to all his creatures, his mercy to sinful men, his justice, his veracity, &c. And, as I long since noted, we may rationally conceive, that he may have divers attributes, and consequently divers perfections, whereof we have at present no knowledge, or perhaps so much as particular conjecture; the inexhaustible fecundity of the divine nature being such, that, for aught we know, we are acquainted with but a small part of the productions of an almighty power, accompanied with an infinite wisdom, and excited to communicate itself by an exuberant goodness. And indeed I see not, why we may not say, that by the notion or idea we have of him, and by the help of some attributes we already know he has, we may in general conceive, that he has other perfections, that we yet know not in particular; since of those attributes, that we do already know, though the irrelative ones (if I may so call them) such as his self-existence, eternity, simplicity, and independency, may be known by mere speculation, and, as it were, all at once, by appearing to us as comprehended in the notion of a being absolutely perfect; yet there are divers relative attributes or perfections, that come to be known successively, and as it were by experience of what he has actually done in relation to some of his creatures: as the

mercy of God was not known by *Adam* himself before his fall; and God's fidelity or faithfulness to his promises, as particularly that of sending the *Messias* in the fulness of time, was not, (not to say could not be) known but in process of time, when some of them came to be fulfilled: and therefore, since some of God's perfections require or suppose the respective natures and conditions of his creatures, and the actings of some of them towards him, as well as some of his towards them; we, that cannot be at all sure, that he may not have made many sorts of creatures, and have had divers relations to them, according to their several states and conditions, that we are altogether unacquainted with, cannot know, but that some of the attributes of God exercised towards these creatures may remain unknown to us.

29. But whether the attributes, known and unknown, be thought to be more or fewer, it will not be denied, but that the natural and genuine result of all these divine perfections, (which we conceive under distinct notions, because we are not able to see them at one view, united in God's most simple essence) must be a most glorious majesty, that requires the most lowly and prostrate veneration of all the great creator's intelligent works: and accordingly we may observe (from some of the formerly cited texts) that the angels, who of all his mere creatures are the most excellent and knowing, are represented in the scripture as assiduously employing themselves, not only in obeying and serving, but in praising and adoring the divine majesty. The very name of angel in the original languages of the Old and New Testament, is a name of ministry, the Hebrew *Malach*, and the Greek *ἄγγελος*, signifying properly a messenger. And our Saviour intimates in his most excellent pattern of prayer, that the will of God is done most obsequiously and cheerfully in heaven; since Christians are directed to wish, that their obedience there paid him might be imitated upon earth. And as they stile themselves the apostles fellow-servants, so these celestial envoys (if I may so call them) make no scruple of going upon the meanest errands, as we would think them; considering rather by whom, than to whom, or about what, they are sent. So the first angel, that we read of, to have been sent to a particular person, was employed to *Hagar*, a wandering and fugitive female slave, ready to perish for thirst in a wilderness, to direct her to a well of water, and tell her somewhat, that concerned her child: and another angel is represented as taking the part of an ass against a false prophet; nay, of this glorious order of creatures in general the scripture tells us, that *they are all ministering spirits, sent forth to minister for them, who shall be heirs of salvation.*

THOUGH the angels are creatures so glorious in their apparitions here below, that they use to strike amazement and veneration, if not terror, even into the excellent persons they appear to, (as we may learn from divers passages of the scripture, where we are told, that their presence was accompanied with a surprizing splendor, and one of them is represented in the apocalypse, as *inlightening the earth with his glory*; and though their multitude be so great, that sometimes the myriads of them and sometimes the legions, are mentioned, and elsewhere we are told of *thousand thousands, and ten thousand times ten thousand of them*: yet these celestial courtiers, that, in comparison of us men, are so glorious, as well as intelligent and spotless, when they appear in multitudes about the throne of God, (according to that vision of the prophet, who told the two Kings of *Judah* and *Israel*, that he saw the *Lord sitting on his throne; and all the hosts of heaven standing by him on his right hand and on his left*;) they stand not to gaze, but, as the prophet *Daniel* expressly says, to minister. And in *Isaiab's* vision, the seraphims themselves are represented, as covering their faces before their great maker seated on his elevated throne. And we may easily guess, that their employment is most humbly to adore and celebrate such dazzling majesty,

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Rev. xix.
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Gen. xxi.
17. &c.

Num. xxii.
33.

Heb. i. 14.

Dan. x. 9.
11, 17.
Luke i. 29.
Rev. xviii.
1.

3 Kings
xxii. 19.
Dan. vii.
10.
Isa. vi. 2.

by what we are told of their crying one to another, *Holy, holy, holy, is the Lord of hosts, the whole earth is full of his glory.* This profound respect of the angels is not to be marvelled at; since, where esteem springs not from ignorance but knowledge, the greater the ability and opportunities are of having the knowledge clear and heightened, the greater veneration must be produced in an intelligent being for the admired object, whose perfections are such, that even an angelical intellect cannot fully reach them; since, as a line, by being never so much extended in length, cannot grow a surface, so neither can created perfections be by any ideas so stretched, as to be amplified into divine ones, (or ideas equal to them.) And indeed, speaking in general, the creatures are but umbratile (if I may so speak) and arbitrary pictures of the great creator; of divers of whose perfections though they have some signatures, yet they are but such, as rather give the intellect rises and occasions to take notice of and contemplate the divine originals, than they afford true images of them: as a picture of a watch or man, or the name of either of them written with pen and ink, does not exhibit a true and perfect idea of a thing (whose internal constitution a surface cannot fully represent) but only gives occasion to the mind to think of it, and to frame one. And what I have said of the creatures in general, holds true of the angels themselves, who by several prerogatives do indeed much surpass the rest of their fellow creatures, but yet are but creatures, and therefore of a nature infinitely inferior to God's; as, though a thousand is a far greater number than ten, and a million than a thousand, yet the latter as well as the two former is beyond computation distant from a number supposed to be infinite; since otherwise a finite number (that by which the lesser differs from the greater) would be able by its accession to make a finite number become infinite. But to return to what I was saying of the angels: I thought fit to mention both the nobleness of their nature, the splendour of their apparitions, and the profound veneration and ardent devotion, which they paid to their creator, because we are wont to estimate remote things by comparison; as modern philosophers tell us, that we judge the rising or setting sun and moon to be greater and more distant from us, than when they are nearer the meridian; because, when they are in the horizon, we consider them as placed beyond mountains, or long tracts of land or sea, that we know to be great objects, and look upon as remote ones, and yet see them interposed, and consequently nearer than the celestial globes. For thus, since the scripture proposes the angels to our imitation, the awful reverence paid to the supreme Being by those excellent spirits, who, as St. Peter tells us, *are greater in power and might than we*, ought to admonish us of the ecstatic respect we mortals owe him, and teach us, that whensoever we speak either to God or of him, we ought to be inwardly affected (and in our outward expressions appear to be so) with the unmeasurable distance there is between a most perfect and omnipotent creator, and a mere impotent creature, as well as between a most holy God, and a most sinful man. Jude 9.
2 Pet. ii. 11.

[30. If the conjectures formerly proposed about worlds differing from ours may pass for probable, then it will be so too, that God in these other systems may have framed a multitude of creatures, whose fabric and motions, and consequently whose properties and operations, must be very differing from what is usually met with in our world. And the various contrivances, wherein those differences consist, will be so many peculiar instances, as well as productions, of the manifold wisdom of the great *former of all things*; or (as the original expression *yotser bakol* will bear,) *Maker of the whole* (universe.) But to add something now of nearer affinity to what was last said about God's government of spirits, how much will this architectonic wisdom (if I may so call it) exerted in framing and regulating an innumerable company of differ-

ing creatures, be recommended; if the other worlds or vortexes we not long since spoke of, and the invisible part of ours, (as we may call the air and æther) be peopled with intelligent, though not visible inhabitants? For, though the scripture seems not to speak expressly of any more sorts of spirits, than those good ones, that retain the name of (the whole genus) angels, and the apostates, that are commonly called devils, because these are the two sorts of spirits, that it most concerns us men to be informed of; yet the scripture, that in the history of the creation does not clearly so much as mention the production of angels, and elsewhere represents them, as well the bad as the good, of very differing orders, (as far as we can guess by the several names it gives them;) the scripture, I say, does not deny, that there are any other sorts of spirits, than those it expressly takes notice of: so that, without any affront to it, we may admit there are such, if any probable arguments of it be suggested to us either by reason or experience. And it seems not very likely, that while our terraqueous globe, and our air, are frequented by multitudes of spirits, all the celestial globes, (very many of which do vastly exceed ours in bulk) and all the ætherial or fluid part of the world, (in comparison of which, all the globes, the celestial and terrestrial put together, are inconsiderable for bulk) should be quite destitute of inhabitants. I have not time to set down the opinions of the antient as well Eastern as Grecian writers, especially the Pythagoreans and Platonists, to whose master this sentence is ascribed concerning the multitudes of dæmons, (a name by them not confined to evil spirits) that lived in the superior part of the world, *Δαίμονες ἀγίων γένεσθαι*. I will not presume to be positive in declaring the sense of those two expressions, which the scripture employs, where speaking of the head of the satanical kingdom, it calls him *the prince of the power of the air*, (and the word air is, among the Hebrews, taken in a great latitude, and several times used for the word heaven) and where speaking of the grand adversaries of the gospel, it styles them *spiritual wickednesses*, or rather (as the Syriac reads it, *spirits of wickedness*, that is) *wicked spirits*, not in high places, as our translators have it, but in heavenly. But though, as I was saying, I will not be positive in giving these two texts such a sense, as may make them direct arguments for my conjecture; yet it seems, that if they do not require, at least they may well bear, an interpretation suitable to my present purpose. And whatever become of the assertions of heathen philosophers and poets, it is very considerable what is noted by the excellent *Grotius*, (who quotes several Hebrew authors for it) that it was the opinion of the *Jews*, that all places from earth to heaven, even the starry heaven, are full of spirits. If this be so, the wisdom and power of God must reach much farther, than we are commonly aware of; since he has created, and does govern, such an inestimable multitude of spiritual beings, of various kinds, each of them endowed with an intellect and will of its own; especially since, for aught we know, many or most of them, and perhaps some whole orders of them, are yet in a probational state, wherein they have free-will allowed them; as *Adam* and *Eve* were in *Eden*, and all the angels were, before some of them (as the scripture speaks) *left their first estate* and their own mansion. And if to these angelical communities we add those others of children, idiots, and mad-men; of whom, though all be in a sense rational creatures, yet the first community have not attained the full use of reason, for want of age, and the two others cannot exercise that faculty, for want of rightly disposed organs; the wisdom and power of God in the divine government of such various and numerous communities of intellectual creatures will, to a considering man, appear the more illustrious and wonderful.

31. THE distance betwixt the infinite creator and the creatures, which are but the limited and arbitrary productions of his power and will, is so vast, that all the di-

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Eph. vi.
12.
compared
with Col.
i. 16,

Eph. ii. 2.

Grotius
on Eph. ii.
2.
On Eph.
vi. 12.

Ep. Jud. 6.

vine attributes or perfections do by unmeasurable intervals transcend those faint resemblances of them, that he has been pleased to impress, either upon other creatures, or upon us men. God's nature is so peculiar and excellent, that there are qualities, which, though high virtues in men, cannot belong to God, or be ascribed to him without derogation; such as are temperance, valour, humility, and divers others: which is the less to be wondered at, because there are some virtues (as chastity, faith, patience, liberality) that belong to man himself, only in his mortal and infirm condition. But whatever excellencies there be, that are simply and absolutely such, and so may, without disparagement to his matchless nature, be ascribed to God, such as are eternity, independency, life, understanding, will, &c. we may be sure, that he possesses them; since he is the original author of all the degrees or resemblances we men have of any of them. And the Psalmist's ratiocination is good, *He that planted the ear, shall he not hear? He that formed the eye, shall he not see? He that teacheth man knowledge, shall not he know?* Psal. xciv. 9, 10. since all the perfections communicated to, or to be found in the creatures, (whether men, angels, or any other) being emanations of the divine excellencies, do as much belong to God, as in a bright day all the luminous beams, that are to be found in the air, belong to the sun; (in whom they are united, and from whom they all proceeded.) The vast difference then between the perfections of the great creator, and those, that are analogous to them in the creatures, reaches to all the perfections, that are, though in very differing manners, to be found in both; but yet the human understanding, as it values itself upon nothing more than wisdom and knowledge, so there is nothing that it esteems and reverences more in other beings, and is less willing to acknowledge itself surpassed in: for which reason, as I have in the foregoing part of this paper inculcated by more than one way, the great superiority of God's intellect to man's; so I think it not improper to prosecute the same design, by mentioning to you some few particulars, whereby that superiority may manifestly appear. We may then consider, that besides God knows an innumerable company of things, that we are altogether unacquainted with, since he cannot but know all the creatures he has made, whether visible or invisible, corporeal or immaterial, and what he has enabled them to do, according to that of St. James, *Known unto God are all his works from the beginning of the world*; nay, since he cannot but know the extent of his own infinite power, he cannot but know numberless things as possible, that he has not yet made, nor perhaps ever will please to make. Acts xv. 18. But to confine myself to things actually existent, besides his corporeal and immaterial creatures, and their faculties or powers, whereof we have some kind of notice, and besides perhaps multitudes of other things, whereof we have no particular idea or conjecture; he knows those things whereof we men have also some knowledge, in a manner or degree peculiar to himself: as what we know but in part, he knows clearly, and what we know but by fallible mediums, he knows most certainly.

32. But the great prerogative of God's knowledge is, that he perfectly knows himself; that knowledge being not only too wonderful for a man (as even an inspired person confesses touching himself) but beyond the reach of an angelical intellect; since fully to comprehend the infinite nature of God, no less than an infinite understanding is requisite. And for the works of God, even those, that are purely corporeal (which are therefore the meanest) our knowledge of these is incomparably inferior to his: for though some modern philosophers have made ingenious attempts to explain the nature of things corporeal, yet their explications generally suppose the present fabric of the world, and the laws of motion that are settled in it; but God knows particularly, both why and how the universal matter was first contrived into

this admirable universe, rather than a world of any other of the numberless constructions he could have given it; and both why those laws of motion, rather than others, were established; and how senseless matter, to whose nature motion does not at all belong, comes to be both put into motion, and qualified to transfer it according to determinate rules, which itself cannot understand. But when we come to consider the particular and more elaborate works of nature; such as the seeds or eggs of living creatures, or the texture of quicksilver, poisons, antidotes, &c. the ingenious confess their ignorance, (about the manner of their production and operations) and the confident betray theirs. But it is like we men know ourselves better, than what is without us; but how ignorant we are at home, if the endless disputes of *Aristotle* and his commentators and other philosophers about the human soul, and of physicians and anatomists about the mechanism and theory of the human body, were not sufficient to manifest it, it were easy to be shewn (as it is in another paper) by the very conditions of the union of the soul and body; which being settled at first by God's arbitrary institution, and having nothing in all nature parallel to them, the manner and terms of that strange union is a riddle to philosophers, but must needs be clearly known to him, that alone did institute it, and, (all the while it lasts) does preserve it. And there are several advantages of the divine knowledge above that of man, that are not here to be pretermitted; for first, we men can perceive and sufficiently attend but to few things at once; according to the known saying,

Pluribus intentus minor est ad singula sensus.

AND it is recorded as a wonder of some great men among the ancients, that they could dictate to two or three secretaries at once. But God's knowledge reaches at once to all, that he can know; his penetrating eyes pierce quite through the whole creation at one look; and, as an inspired penman declares, *there is no creature, that is not manifest in his sight, but all things are naked*, and (if I may so render the greek word) *extraverted to his eyes*. He always sees incomparably more objects at one view, than the sun himself endued with sight could do; for God beholds at once all, that every one of his creatures, (whether visible or invisible to us) in the vast universe, either does or thinks. Next, the knowledge of God is not a progressive or discursive thing, like that acquired by our ratiocinations, but an intuitive knowledge; since, though we men, by reason of the limitedness and imperfections of our understandings, are fain to make the notice we have of one thing a step and help to acquire that of another, which to us is less known; as may easily be observed even in the forms of syllogisms; yet God, whose knowledge, as well as his other attributes are infinitely perfect, needs not know any one thing by the help of another: but knows every thing in itself (as being the author of it;) and all things being equally known to him, he can, by looking, if I may so speak, into himself, see there, as in a divine and universal looking-glass, every thing that is knowable, most distinctly, and yet all at once. *Thirdly*, God knows most men's secret thoughts and intentions; whence he is called *Καρδιανυσκώων*, and the *searcher of all hearts, that understandeth all the imaginations of the thoughts*. Nay, he knows men's thoughts afar off, and even never vented thoughts, which the man himself may not know; for not only St. *John* says, *that if our heart condemn us, God is greater than our heart, and knows all things*; but God enabled *Daniel* to declare to *Nebuchadnezzar* the whole series of the prophetick dream, whereof that monarch's own memory could not retrieve any part. And here give me leave to observe, (what perchance you have not minded) that even of a thing, that happens to a man's self, and is of a nature capable to make the most vivid impressions on him, God's knowledge may surpass his; since St. *Paul* speaking of his being caught up into paradise, after

The Title of this Paper is, *The Imperfection of Human knowledge manifested by its own light.*

Heb. iv.

13.
τελπα. η-
λίσμνα.

1 Chron.

xviii. 9.

Psalms

cxxxix. 2.

1 Joh. iii.

20.

Dan. ii. 5.

31.

having twice said, *whether in the body I cannot tell, or whether out of the body I cannot* ² Cor. xii. ^{3, 4} *tell*, he both times subjoins, that *God knows*. Our knowledge of ourselves, as well as that of those other creatures, that are without us, being so defective, the confidence of some, that dare pretend to know God fully by the light of their natural reason, will not hinder me from taking hence a rise to ask this short question: *How imperfect must mere philosophers knowledge of God's nature be, since they know him but by his works, and know his works themselves but very imperfectly?* The other and fourth conspicuous prerogative of the divine knowledge, is the prescience of future contingents, that depend upon the determinations and actions of free agents: for we men are so far from being able to stretch our knowledge to the discovery of that sort of events, that the greatest clerks have tried their wits in vain to discover, how God himself can foreknow them; and therefore too many, even among Christians, deny, that he can, though by divers accomplished predictions recorded in scripture, it manifestly appears that he does.

33. WHEN I consider the transcendant excellency, and the numerous prerogatives of the Deity, I cannot without wonder, as well as trouble, observe, that rational men professing Christianity, and many of them studious too, should wilfully, and perhaps contemptuously, neglect to acquire or reflect on those notices, that are apt to increase their knowledge of God, and consequently their veneration for him. To aspire to a farther knowledge of God, that we may the better adore him, is a great part both of man's duty and his happiness. God, who has put into men an innate desire of knowledge, and a faculty to distinguish the degrees of excellency in differing notices, and to relish those most, that best deserve it, and has made it his duty to search and inquire after God, and to love him above all things, would not have done this, if he had not known that those, that make a right use of their faculties, must find him to be the noblest object of the understanding, and that which most merits their wonder and veneration. And indeed, what can be more suitable to a rational creature, than to employ reason to contemplate that divine being, which is both the author of its reason, and the noblest object, about which it can possibly be employed? The knowledge of some dead language, or some old rusty medal, or the opinions and customs of some nations or sects, that did not perhaps reason nor live any better, than we do now, are thought worthy of curiosity, and even of the laborious industry of learned men; and the study of things merely corporeal, gains men the honourable title of philosophers. But whatever these objects of inquiry be in themselves, it is certain the greatest discoveries we can make of them are but trifles, in comparison of the excellency of the knowledge of God, which does as much surpass that of his works, as he himself does them. And it is the prerogative of his nature, to be infinitely above all that he has made; whether we contemplate the works of nature, or those of art, whereof the former are, under another name, his more immediate works; and the others the effects of one of his works; and by consequence are originally his, though produced by the intervention of man. And though it be most true, that on the corporeal world God has been pleased to stamp such impresses of his power, wisdom and goodness, as have justly exacted the admiration even of philosophers, yet the great author of the world is himself incomparably superior to all his workmanship, insomuch, that, though he could have made, and always will be able to make, creatures more perfect, than those he has made, by innumerable degrees of perfection; yet the prerogative of his nature will keep him necessarily superior to the excellentest creatures he can make, since the very condition of a creature hinders it from being (to name now no other of the divine attributes) self-existent and independent. It is therefore methinks a sad thing, that we men should grudge to spend now and then a few hours in the contemplation and internal worship of that most glorious and perfect being, that continually employs the devotion of Angels themselves. This I judge probable from hence, that those blessed spirits

spirits are represented in the scripture, as celebrating with joyful songs and acclamations the nativity of the world; and I think they may well be supposed to have an ardent desire to obtain a farther knowledge of God himself; since, as an Apostle assures us, they earnestly desire to look into the truths contained in the gospel, and the dispensations of God towards frail and mortal men.

34. I KNOW I may be told, that *scrutator majestatis*, &c. and that it is a dangerous thing to be inquisitive about the nature of God; but not to urge, that the Latin sentence is taken but out of an apocryphal book, I answer, that the secret things of God, that are to be left to himself, seem to be his unrevealed purposes and decrees, and his most abstruse essence or substance, the scrutiny whereof I readily acknowledge not to belong to us; but I think there is a great difference between contemplating God out of a saucy curiosity, merely to know somewhat, that is not common of him, and doing it out of an humble desire, by a farther knowledge of him to heighten our reverence and devotion towards him. It is an effect of arrogance to endeavour, or so much as hope, to comprehend the divine perfections so, as to leave nothing in them unknown to the inquirer: but to aspire to know them farther and farther, that they may proportionably appear more and more admirable and lovely in our eyes, is not only an excusable, but a laudable curiosity. The scripture in one place exhorts us *to grow not only in grace, but in the knowledge of Christ*; and in another, *to add to our virtue knowledge*; and when *Moses* begged to be blessed with a nearer and more particular view of God, though part of his request was refused, because the grant of it was unsuitable to his mortal state, and perhaps must have proved fatal to him, whilst he was in it; yet God vouchsafed so gracious a return to his petition, as shews he was not displeased with the supplicant; no action or suffering of his having procured for him so glorious a view, as was then vouchsafed to his holy curiosity. And that we may aspire to great degrees of knowledge, even at those supernatural objects, that we cannot adequately know, we may learn from *St. Paul*, who prays, that his *Ephesians*, as all true Christians, may be able to comprehend what is the breadth and length and depth and height, and to know the love of Christ, which, says he in the very next words, passeth knowledge. Supposing it then lawful to contemplate God, not with design to pry into his decrees and purposes, not to dogmatise in points controverted among the learned about his nature and attributes, but to excite in ourselves the sentiments, which his indisputable perfections are by a more attentive view qualified to produce; I consider, that the devout contemplation of God, besides other great advantages, that it brings the mind, insomuch that the human understanding, like *Moses* in the mount, does by an assiduous converse with God acquire a lasting luminousness; besides this, I say, and the improving influence, that this happy conversation may have upon the graces and virtues of the mind, I take it to be one of the most delightful exercises, that the soul is capable of on this side Heaven. It is generally acknowledged, that admiration is one of the most pleasing affections of the mind, which sometimes, when the object deserves it, is so possessed thereby, as to forget all other things, or leave them unregarded; as it often happens in masks, and other pompous and surprising shews or spectacles; and as, upon a better ground, it happened to *St. Peter*, when being ravished with the glorious transfiguration of his and our master upon mount *Tabor*, he exclaimed, that it was good for them to be there, and talked of building tabernacles for those that had heavenly manfions, being so transported with the ravishing sight, that the evangelist expressly notes, that *he knew not what he said*. Now, the pleasure, that admiration gives, being usually proportionate to the uncommon nature and endearing circumstances of the thing admired, how can any admiration afford such a contentment, as that, which has God himself for its object, and in him the most singular and the most excellent of all Beings? The wonder produced in us by an humble and attentive contemplation of God has

two main advantages, above the admiration we have for any of his works, or of our own. For first, when we admire corporeal things, how noble and precious soever they be, as stars and gems, the contentment, that accompanies our wonder, is allayed by a kind of secret reproach grounded on that very wonder; since it argues a great imperfection in our understandings, to be posed by things, that are but creatures, as well as we, and, which is worse, of a nature very much inferior to ours: whereas it is no disparagement at all for a human, and consequently for a finite intellect, to be possessed with wonder, though it were heightened to amazement or astonishment, by the contemplation of that most glorious and infinitely perfect Being, which must necessarily exceed the adequate comprehension of any created intellect. But I consider, that there is a farther and much greater (which is the second) advantage of the admiration of God above that of other things; for other objects having but a bounded nature, and commonly but some one thing fit to be wondered at, our admiration of them is seldom lasting, but, after a little familiarity with them, first languishes and then ceases: but God is an object, whose nature is so very singular, and whose perfections are so immense, that no assiduity of considering him can make him cease to be admirable, but the more knowledge we obtain of him, the more reason we find to admire him; so that there may be a perpetual vicissitude of our happy acquiescence of farther degrees of knowledge, and our eager desires of new ones. Because we give him but one name, we are apt to look upon him, as but one object of speculation; but though God be indeed but one in essence or nature, yet such is his immensity, and, if I may so speak, fecundity, that he is unspeakably various in the capacity of an object. Thus heaven goes under one name, but contains so many fixed stars and planets, and they, by their diversity of motions, exhibit so many phenomena, that though they have employed the curiosity of astronomers for many ages, yet our times have, in the celestial part of the world, made discoveries as considerable, if not as numerous, as all those of the antients; and as our optick glasses have detected many fixed stars, and divers planets, that were unknown to former times, so our navigators, by their voyages beyond the line, have discovered divers whole constellations in the southern hemisphere: so that though heaven be an object, that has been perpetually and conspicuously exposed to men's view and curiosity for some thousands of years, yet it still affords new subjects for their wonder; and I scarce doubt, but by the farther improvements of telescopes posterity will have its curiosity gratified by the discovery both of new constellations, and of new stars in those, that are known to us already. We need not therefore fear our admiration of God should expire, for want of objects fit to keep it up. That boundless ocean contains a variety of excellent objects, that is as little to be exhausted, as the creatures, that live in our sublunary ocean, or lie on the shores, that limit it, can be numbered. To the wonderful excellency of God may be justly applied that notion, which *Aristotle* lays down as a kind of definition of infinite; namely, that it is that, of which how much soever one takes, there still remains more to be taken. If the intellect should for ever make a farther and farther progress in the knowledge of the wonders of the divine nature, attributes and dispensations; yet it may still make discoveries of fresh things worthy to be admired: as in an infinite series, or row of ascending numbers, though you may still advance to greater and greater numbers, yet all that you can do by that progress, is to go farther and farther from the first and least term of the progression, (which in our case answers to the smallest degree of our knowledge of God) without ever reaching, or, which may seem strange, but is true, so much as approaching to an infinite number, (in case there were any such) or even to the greatest of all numbers; as will be acknowledged by those, that have looked into the properties of progressions *in infinitum*.

35. THE two advantages I come from mentioning, which the admiration of God has, in point of delightfulness, joined to the other advantages of our contemplation of him, have, I hope, persuaded you, that they are very much wanting to themselves, as well as to the duty they owe their Maker, that refuse or neglect to give their thoughts so pleasing, as well as noble an employment. And I am apt to think, upon this account in particular, that reason is a greater blessing to other men, than to atheists, who, whilst they are such, cannot employ it about God, but with disbelief or terror; and that on this very score *Epicurus* was far less happy than *Plato*; since whereas the latter was oftentimes, as it were, swallowed up in contemplation of the Deity, the former had no such glorious object to possess him with an equally rational and delightful admiration.

36. BUT now, (to apply this to the scope of this whole discourse) though so pure and spiritual a pleasure is a very allowable attractive to elevate our thoughts to the most glorious and amiable of objects; yet it ought to be both the design and the effect of our admiration of God, to produce in us less unworthy ideas, and more honourable and reverent thoughts of that wonderful and unparalleled Being; of whom the more we discover, the more we discern him to be superior to all his works, and particularly to ourselves, who are not of the highest order of them, and who, as mere men, are scarce in any thing more noble, than in the capacity and permission of knowing, admiring and adoring God; which he that thinks a mean and melancholy employment, might be to seek for happiness in heaven itself, if so unqualified a soul could be admitted there. The genuine effect of a nearer or more attentive view of infinite excellency is a deep sense of our own great inferiority to it, and of the great veneration and fear we owe (to speak in a scripture phrase) to this glorious and fearful name, (that is object) *The Lord our God*. And accordingly, when God had spoken to *Job* out of the whirlwind, and declared somewhat to him of the divine greatness, this holy philosopher much alters his style, and confesses, that in his former discourses of God, he had uttered what he understood not, things too wonderful for him, which he knew not: and having thereupon implored instruction from God, he declares how fit a nearer knowledge of him is to make a man have low thoughts of himself; *I have heard of thee*, (says he to his Maker) *by the hearing of the ear, but now mine eye seeth thee: wherefore* (infers he) *I abhor myself, and repent in dust and ashes*.

I KNOW you may look upon a good part of this excursion as a digression; but if it be, it will quickly be forgiven, if you will pardon me for it, as easily as I can pardon myself for finding myself in *David's* case, when he said, *my heart was hot within me, while I was musing the fire burned*, as he said, *then spake I with my tongue*: so I was content to let my pen run on in so pleasant and noble a theme, and endeavour to excite, at least in myself, such a well grounded admiration of God, as may perhaps be a part of my reasonable service to him, or rational worship of him. God is pleased to declare, that he that offers (or, as it is in the original, sacrifices) praise, glorifies him; and the scripture expressly stiles our devotion *sacrifices of praise*. And we may well suppose, that if the *calves of our lips*, as our celebrations of God are somewhere called, are encouraged by God, those mental offerings, that consist in high and honourable thoughts of him, and in lowly humble sentiments of ourselves, in the view of his excellency, will not be less acceptable to him; such reverence and devout fear (to speak with the inspired writer to the Hebrews) being indeed a kind of *adoring God in spirit and in truth*; and he that is so employed, may with contentment compare his condition to that of *Zacharias*, when it was said of him, that *his lot was to burn incense*, to offer up to God the noblest and purest sort of the legal sacrifices. But, that I may not too far digress, I shall only add, that I think myself very worthily, as well as delightfully

Deut.
xxviii.
58.

Job xlii.
3, 4, 5, 6.

Psal.
xxxix. 3.

Rom. xii.
2.
Psal. l. 25.
Heb. xiii.
15.

Heb. xii.
28.

John iv.
23.
Luke i. 9.

lightfully employed, when I am seeking after, and bringing together, what helps I can, to greaten, as much as I am able, those sentiments of wonder and veneration for God, that I am sure can never be great enough; especially since the more we know and adore that infinite excellency and exuberant fountain of goodness, the more influence and advantages we derive from it: agreeably to which, God is introduced in the scripture, saying of one of his adorers, to whom, in the same psalm, many other blessings are also promised, *because he has set his love upon me, therefore will I deliver him: I will set him on high, because he has known my name.* Psal. xci.
14, 15, 16.

WE have generally, through incogitancy, or vice, or prejudices, or the majesty and abstruseness of the subject, so great an indisposition to excite and cherish in ourselves an awful veneration for God, and a studious contemplation of his adorable attributes, that it seemed no more than needful to employ variety of arguments, drawn from different topicks, to engage our own and other men's minds, and repeated inculcations to press them to an exercise, which they neither are, nor are willing to be acquainted with. This consideration will, I hope, be my apology, if, in the present tract, I lay hold on several occasions, and make use of diversities of discourse, to recommend a duty, that does very much both merit, and need to be not only proposed but inculcated; and yet I will not any farther lengthen this foregoing excursion, (as I hope you will think it, rather than a mere digression,) nor any longer forget, that when I begun it, I was discoursing of the great caution and profound respect with which we ought to speak of God.

37. IT were tedious to insist on all the arguments, that may be brought of the immense inferiority of man's intellect to God's; and therefore I shall here content myself to illustrate some part of it, by a simile borrowed from the superior and inferior luminaries of heaven; human reason, in comparison of the divine intellect, being but like the moon in reference to the sun. For as the moon, at best, is but a small star in comparison of the sun, and has but a dim light, and that too but borrowed; and has her wane, as well as her full, and is often subject to eclipses, and always blemished with dark spots: so the light of human reason is but very small and dim, in comparison of his knowledge, that is truly called in scripture the *Fountain*, as the *Father*, of light; and this light itself, which shines in the human intellect, is derived from the irradiation it receives from God, *in whose light* it is, that *we see light*. Psal. xxxvi. 9.
Jam. i. 17. And this, as it is but a communicated light, is subject to be increased, impaired, and oftentimes to be almost totally eclipsed, either by the darkening fumes of lusts or passions, or the suspension of the provoked donor's beams, and, in its best state, is always blemished with imperfections, that make it incapable of an entire and uniform illumination.

UPON these and divers other considerations I, for my part, think it becomes us men to use an awful circumspection, not only when we make philosophical inquiries or scholastic disputes about God, that is, when we presume to discourse of him; but when we solemnly design to praise him; for it is one thing to say true things of God, and another to say things worthy of God. Our ideas of him may be the best we are able to frame, and yet may far better express the greatness of our veneration for him, than the immensity of his perfections: and even those notions of them, that may be worthy of the most intelligent of men, will fall extremely short of being worthy of the incomprehensible God. The brightest and least unlike idea we can frame of God, is infinitely more inferior in reference to him, than a parhelion is in reference to the sun: for, though that meteor appear a splendid and sublime thing, and have so much resemblance to the sun (without whose own beams it is not produced) as to be readily perceived to be his image, exclusively to that of any other: yet residing in a cloud, whose station is near the earth, it is by an immense distance beneath the sun, and is no

less inferior to him in bigness and in splendor, as well as in many other attributes. He has, in my opinion, the truest veneration for God, not who can set forth his excellencies and prerogatives in the most high and pompous expressions; but he, who willingly has a deep and real sense of the unmeasurable inferiority of himself, and his best ideas, to the unbounded and unparalleled perfections of his Maker. And here indignation prompts me to this reflection, that if [since] even our hymns and praises of God, the supreme Being, deserve our blushes, and need his pardon, what confusion will one day cover the faces of those, that do not only speak slightly and carelessly, but oftentimes contemptuously, and perhaps drollingly, of that supreme and infinitely perfect Being, to whom they owe those very faculties, and that wit, which they so ungratefully, as well as impiously misemploy? And indeed, such transcendent excellencies, as the divine ones must be, might justly discourage us from offering so much as to celebrate them, if infinite goodness were not one of them. I shall not therefore allow myself the presumption of pretending to make, as it were, a panegyric of God, of whom it is very easy to speak too much, though it be not possible to say enough; contenting myself with an humble adoration of perfections, whereof my utmost praises would rather express my own weakness than their excellency; since of this ineffable object, the highest things, that can be expressed in words, must therefore fall short, because words cannot express them: which assertion, though it be a paradox, yet I think it is not truly an hyperbole; for we are not able to determine and reach, so much as in our thoughts, the greatest of all possible numbers; since we may conceive, that any one (whatsoever it be) that can be pitched upon or assigned, may be doubled, trebled, or multiplied by some other number, or may be but the root of a square or cubical number. By which instance (that perhaps you have not met with) you may perceive, that any determinate conception, that we can have (for example) of God's immensity (to specify now no other of his attributes) must therefore be short of it, because it is a determined or bounded conception. It is fit therefore, that I should at length put limits to my discourse, since none can be put to the extent or perfections of my subject.

THE C O N C L U S I O N.

THE result of what hath been said in the past excursion, will, I hope, amount to a sufficient justification of what hath been said at the beginning of this discourse about *The high veneration our intellects owe to God.* For since we may well think in general, that he hath divers attributes and perfections, of which we have no knowledge or suspicion in particular; and since of those attributes of his, that are the most manifest to us, as his power and wisdom, we have but a very dim and narrow knowledge, and may clearly perceive, that there is in these an unbounded extent of perfection, beyond all that we can evidently and distinctly discern of them; how unfit must such imperfect creatures, as we are, be to talk hastily and confidently of God, as of an object, that our contracted understandings grasp, as they are able (or pretend to be so) to do other objects! And how deep a sense ought we to have of our inestimable inferiority to a Being, in reference to whom, both our ignorance and our knowledge ought to be the parents of devotion! since our necessary ignorance proceeds from the numerousness and incomprehensibleness of his (many of them undiscovered) excellencies, and our knowledge qualifies us but to be the more intelligent admirers of his conspicuous perfections.

If we duly and impartially consider these and the like things, we may clearly perceive, how great an effect and mark of ignorance, as well as presumption, it is, for us mortals, to talk of God's nature and the extent of his knowledge, as of things,
that

that we are able to look through, and to measure. Whereas we ought, whenever we speak of God and of his attributes, to stand in great awe, lest we be guilty of any misapprehension or misrepresentation of him, that we might, by any wariness and humility of ours, have avoided; and lest, by an over-weening opinion of ourselves, we presume, that we have a perfect, or, at least, a sufficient knowledge of every thing in God, whereof we have some knowledge; since this, at the least, consists in such notions, as are rather suited to our limited faculties, than any way equal to his boundless perfections.

THAT high order of intellectual beings the angels, though their minds be so illuminated, and their knowledge so extensive; the angels themselves, I say, are in the scripture affirmed to be desirous to pry into the mysteries of the gospel: whence we may guess, how far they are from penetrating to the bottom of what the scripture calls *the depths of God*; and how much farther they are from comprehending the infinite nature of God. And accordingly, when in the (formerly mentioned) majestic vision, that appeared to the prophet *Isaiab*, they are set forth as attendants about the throne of God, they are represented *covering their faces with their wings*, as not able to support, or not presuming to gaze on the dazzling brightness of the divine majesty. And shall we, poor sinful mortals, who are infinitely beneath him, not only by the degeneracy and sinfulness of our lives, but even by the imperfection and inferiority of our nature, presume to talk forwardly or irreverently of the divine essence and perfections, without considering the immense distance betwixt God and us: and how unable, as well as unworthy, we are to penetrate the recesses of that inscrutable, as well as adorable nature; and how much better it would become us, when we speak of objects so much above us, to imitate the just humility of that inspired poet, that said * *Such knowledge is too wonderful for me; it is high, I cannot attain unto it*; and join in that seemingly, and yet but seemingly, lofty celebration of God, † *That his glorious name is exalted above all blessing and praise.*

* Psalm.
cxxxvi. 6.
† Neh. ix.
5.

A
F R E E I N Q U I R Y

Into the VULGARLY RECEIVED

NOTION of NATURE:

MADE IN

An ESSAY addressed to a FRIEND.

Audendum est, et veritas investiganda; quam etiamsi non assequamur, omnino tamen propius, quam nunc sumus, ad eam perveniemus
GALENUS.

The P R E F A C E.

I HAVE often wondered, that, in so inquisitive an age as this, among those many learned men, that have with much freedom, as well as acuteness, written of the works of nature, (as they call them) and some of them of the principles too, I have not met with any, that has made it his business to write of nature herself. This will perhaps hereafter be thought such an omission, as if, giving an account of the political estate of a kingdom, one should treat largely of the civil judges, military officers, and other subordinate magistrates, and of the particular ranks and orders of inferior subjects and plebeians, but should be silent of the prerogatives and ways of administration of the king; or, (to use a comparison more suitable to the subject) as if one should particularly treat of the barrel, wheels, string, balance, index, and other parts of a watch, without examining the nature of the spring, that sets all these a moving. When I say this, I do not forget, that the word Nature is every where to be met with in the writings of physiologists: but, though they frequently employ the word, they seem not to have much considered what notion ought to be framed of the thing, which they suppose and admire, and, upon occasion, celebrate, but do not call in question or discuss. Weighing therefore with myself, of what great moment the framing a right or a wrong idea of nature must be, in reference both to the speculative and practical part of physiology, I judged it very well worth the while, to make, with philosophical freedom, a serious inquiry into the vulgarly received notion of nature; that, if it appeared well grounded, I might have the rational satisfaction of not having acquiesced in it, till after a previous examen; if I should find it confused and ambiguous, I might endeavour to remedy that inconvenience, by distinguishing the acceptions of the word; if I found it dubious as to its truth, I might be shy in trusting too much to a distrusted principle; and, if I found it erroneous, I might avoid the raising superstructures of my own, or relying on those of others, that must owe their stability to an unsound and deceitful foundation. And, because many atheists ascribe so much to nature, that they think it needless to have recourse to a deity for the giving an account of the phænomena of the universe; and, on the other side, very many theists seem to think the commonly received notion of nature little less than necessary to the proof of the existence and providence of God: I, who differ from

from both these parties, and yet think every true theist, and much more every true Christian, ought to be much concerned for truths, that have so powerful an influence on religion, thought myself, for it's sake, obliged to consider this matter, both with the more attention and with regard to religion.

AND yet being to write this treatise as a Physiologer, not a Christian, I could not rationally build any positive doctrine upon mere revelation, which would have been judged a foreign principle in this inquiry: only, since the person, I intentionally addressed my thoughts to, under the name of *Eleutherius*, was a good Christian, I held it not impertinent, now and then, upon the bye, to intimate something to prevent or remove some scruples, that I thought he might have on the score (I say not of natural theology, for that is almost directly pertinent, but) of the Christian faith. But these passages are very few, and but transiently touched upon.

SINCE the reader will be told by and by both that, and why the papers, that make up the following treatise, were not written in one continued series of times, but many years were interposed between the writing of some of them, and that of those, which precede and follow them; I hope it will be thought but a venial fault, if the contexture of the whole discourse do not appear so uniform, nor all the connections of its parts so apt and close, as, if no papers had been lost and supplied, might reasonably be looked for.

I EXPECT the novelty of divers of the sentiments and reasonings proposed in the following discourse will be surprizing, and incline many to look upon the author, as a bold man, and much addicted to paradoxes. But having formerly, in a distinct essay, delivered my thoughts about paradoxes in general, I shall not now engage in that subject, but confine myself to what concerns the ensuing paper. I say then, in short, that in an opinion, I look upon its being new or antient, and its being singular or commonly received, as things, that are but extrinsical to its being true or false: and, as I would never reject a truth, for being generally known or received; so will I not conclude an opinion to be a truth, merely because great numbers have thought it to be so; nor think an opinion erroneous, because it is not yet known to many, or because it opposes a tenet embraced by many. For I am wont to judge of opinions, as of coins: I consider much less in any one, that I am to receive, whose inscription it bears, than what metal it is made of. It is indifferent enough to me, whether it was stamped many years or ages since, or came but yesterday from the *Mint*. Nor do I regard through how many, or how few, hands it has passed for current, provided I know by the touch-stone, or any such trial, purposedly made, whether or no it be genuine, and does or does not deserve to have been current: for, if upon due proof it appears to be good, its having been long and by many received for such, will not tempt me to refuse it. But if I find it counterfeit, neither the prince's image or inscription, nor its date (how antient soever,) nor the multitude of hands, through which it has passed unsuspected, will engage me to receive it; and one disavouring trial, well made, will much more discredit it with me, than all those specious things I have named can recommend.

By this declaration of my sentiments about paradoxes in general, I hope it will be thought, that the motive I had to question that notion of nature, which I dissent from, was not, that this notion is vulgarly received. And I have this to say, to make it probable, that I was not engaged in this controversy by any ambition of appearing in print an heresiarch in philosophy, by being the author of a strange doctrine, that the following discourse was written about the year 1666. (that is, some lustres ago,) and that not long after the youth, to whom I dictated it, having been inveigled to steal away, unknown to me or his parents, into the *Indies*, (whence we never heard of

of him since,) left the loose sheets, wherein (and not in a book) my thoughts had been committed to paper, very incoherent, by the omission of divers necessary passages. Upon which account, and my unwillingness to take the pains to supply what was wanting, those papers lay by me many years together neglected, and almost forgotten; until the curiosity of some philosophical heads, that were pleased to think they deserved another fate, obliged me to tack them together, and make up the gaps, that remained between their parts, by retrieving, as well as after so many years my bad memory was able to do, the thoughts I sometimes had pertinent to those purposes. And indeed, when I considered of how vast importance it is in philosophy, and the practice of physic too, to have a right notion of nature; and how little the authority of the generality of men ought, in so nice and intricate a subject, to sway a free and impartial spirit; as I at first thought myself obliged, since others had not saved me the labour, to make a free inquiry into this noble and difficult subject, so I was afterwards the more easily prevailed with by those, that pressed the publication of it. With what success I have made this attempt, I must leave others to judge. But if I be not much flattered, whatever becomes of the main attempt, there will be found suggested here and there, in the following discourse, some reflections and explications, that will at least oblige the zealous assertors of the vulgar notion of nature to clear up the doctrine, and speak more distinctly and correctly about things, that relate to it, than hitherto has been usual; and that will be fruit enough to recompense the labour, and justify the title of a free inquiry: in prosecution of which, since I have been obliged to travel in an untrodden way, without a guide, it will be thought, I hope, more pardonable than strange, if, in attempting to discover divers general mistakes, I be not so happy as to escape falling into some particular ones myself; and, if among these, I have been so unhappy, as to make any, that is injurious to religion, as I did not at all intend it, so, as soon as ever I shall discover it, I shall freely disown it myself, and pray that it may never mislead others. What my performance has been, I have already acknowledged, that I may be unfit to judge; but, for my intentions, I may make bold to say, they were to keep the glory of the divine author of things from being usurped or intrenched upon by his creatures, and to make his works more thoroughly and solidly understood by the philosophical studiers of them.

I do not pretend, and I need not, that every one of the arguments I employ in the following tract is cogent, especially if considered as single. For demonstrative arguments would be unsuitable to the very title of my attempt; since, if about the received notion of nature, I were furnished with unanswerable reasons, my discourse ought to be stiled, not a free inquiry into the vulgar notion of nature I consider, but a confutation of it; and a heap of bare probabilities may suffice to justify a doubt of the truth of an opinion, which they cannot clearly evince to be false. And therefore, if any man shall think fit to criticize upon the less principal or less necessary parts of this treatise, perhaps I shall not think myself obliged to be concerned at it: and even if the main body of the discourse itself shall be attacked from the press; I, who am neither young nor healthy, nor ever made divinity, philosophy or physic, my profession, am not like to oppose him in the same way: since, as I ought not to wish, that any errors of mine (if this essay teach any such,) should prevail; so, if the things I have delivered be true for the main, I need not despair, but that in such a free and inquisitive age as ours, there will be found generous spirits, that will not suffer weighty truths to be oppressed, though the proposers of them should, by averfeness from contention, or by want of time or health, be themselves kept from defending them: which I have thought fit to take notice of in this place, that the truth

(if I have been so happy, as to have found and taught it,) may not suffer by my silence; nor any reader surmise, that if I shall leave a book unanswered, I thereby acknowledge it to be unanswerable. But this regards only the main substance of our essay, not the order or disposition of the parts; since, if any shall censure that, I shall not quarrel with him about it: for indeed, considering in how preposterous an order the papers I have here tacked together came to hand, and how many things are upon that score unduly placed, I shall not only be content, but must desire to have this rhapsody of my own loose papers looked upon but as an apparatus, or collection of materials, in order to [what I well know this maimed and confused essay is not] a compleat and regular discourse. Yet, (to conclude,) I thought, that the affording even of a little light, in a subject so dark and so very important, might keep an essay from being useless; and that to fall short of demonstration would prove a pardonable fault, in a discourse, that pretends not to dogmatize, but only to make an inquiry.

Sept. 29, 1682.

A FREE INQUIRY into the received NOTION of NATURE.

S E C T. I.

I KNOW not, whether or no it be a prerogative in the human soul, that as it is itself a true and positive Being, so it is apt to conceive all other things, as true and positive beings also: but, whether or no this propensity to frame such kind of ideas supposes an excellency, I fear it occasions mistakes, and makes us think and speak, after the manner of true and positive beings, of such things, as are but chimerical, and some of them negations or privations themselves; as death, ignorance, blindness, and the like.

It concerns us therefore to stand very carefully upon our guard, that we be not insensibly misled by such an innate and unheeded temptation to error, as we bring into the world with us; and consequently I may be allowed to consider, whether among other particulars, in which this deluding propensity of our minds has too great, though unsuspected, an influence upon us, it may not have imposed on us, in the notion we are wont to frame concerning nature: for this being the fruitful parent of other notions, as nature herself is said to be of the creatures of the universe; the notion is so general in its applications, and so important in its influence, that we had need be jealously careful of not over-easily admitting a notion, than which there can scarce be any, that more deserves to be warily examined, before it be thoroughly entertained.

LET me therefore make bold to inquire freely, whether that, of which we affirm, such great things, and to which we ascribe so many feats, be that almost divine thing whose works, among others, we are; or a notional thing, that in some sense is rather to be reckoned among our works, as owing its being to human intellects.

I KNOW most men will be forestalled with no mean prejudices against so venturous an attempt; but I will not do *Eleutherius* the injury to measure him by the preposessed generality of men; yet there are two scruples, which I think it not amiss to take notice of, to clear the way for what shall be presented you in the following discourse.

AND first, it may seem an ingrateful and unfilial thing to dispute against nature, that is taken by mankind for the common parent of us all. But though it be an undutiful thing, to express a want of respect for an acknowledged parent, yet I know not, why it may not be allowable to question one, that a man looks upon but as a pretended one, or at least does upon probable grounds doubt, whether she be so or no; and until it appear to me, that she is so, I think it my duty to pay my gratitude, not to I know not what, but to that deity, whose wisdom and goodness, not only designed to make me a man, and enjoy what I am here blessed with, but contrived the world so that even those creatures of his, who by their inanimate condition are not capable of intending to gratify me, should be as serviceable and useful to me, as they would be if they could and did design the being so: and you may be pleased to remember, that, as men may now accuse such an inquirer, as I am, of impiety and ingratitude towards nature; so the Persians, and other worshippers of the celestial bodies, accused several of the antient philosophers, and all the primitive Christians, of the like crimes, in reference to the sun; whose existence, and whose being a benefactor to mankind was far more unquestionable, than that there is such a semi-deity, as men call nature: and it can be no great disparagement to me, to suffer on the like account with so good company, especially when several of the considerations, that justify them, may also apologize for me. I might add, that it not being half so evident to me that what is called nature is my parent, as that all men are my brothers, by being the off-spring of God; (for the τῆ γὰρ φύσιν ἐσμέν' of *Aratus* is adopted by *St. Paul*) I may justly prefer the doing of them a service, by disabusing them, to the paying of her a ceremonial respect. But setting allegories aside, I have sometimes seriously doubted, whether the vulgar notion of nature has not been both injurious to the glory of God, and a great impediment to the solid and useful discovery of his works.

Acts xvii.

AND first, it seems to detract from the honour of the great author and governor of the world, that men should ascribe most of the admirable things, that are to be met with in it, not to him but to a certain nature, which themselves do not well know what to make of. It is true, that many confess, that this nature is a thing of his establishing, and subordinate to him: but, though many confess it, when they are asked, whether they do or no? yet, besides that many seldom or never lifted up their eyes to any higher cause, he, that takes notice of their way of ascribing things to nature, may easily discern, that, whatever their words sometimes be, the agency of God is little taken notice of in their thoughts: and however, it does not a little darken the excellency of the divine management of things, that, when a strange thing is to be accounted for, men so often have recourse to nature, and think she must extraordinarily interpose to bring such things about; whereas it much more tends to the illustration of God's wisdom, to have so framed things at first, that there can seldom or never need any extraordinary interposition of his power. And, as it more recommends the skill of an engineer to contrive an elaborate engine so, as that there should need nothing to reach his ends in it but the contrivance of parts devoid of understanding, than if it were necessary, that ever and anon a discreet servant should be employed to concur notably to the operations of this or that part, or to hinder the engine from being out of order; so it more sets off the wisdom of God in the fabric of the universe, that he can make so vast a machine perform all those many things, which he designed it should, by the meer contrivance of brute matter managed by certain laws of local motion and upheld by his ordinary and general concurrence, than if he employed from time to time an intelligent overseer, such as nature is fancied to be, to regulate, assist, and controul the motions of the parts: in confirmation of which you may remember, that the later poets justly reprehended their predecessors

for want of skill in laying the plots of their plays, because they often suffered things to be reduced to that pass, that they were fain to bring some deity (*Θεὸς ἀπὸ μηχανῆς*) upon the stage, to help them out.

(*Nec deus interfit, nisi dignus vindice nodus,*) &c.

AND let me tell you freely, that though I will not say, that *Aristotle* meant the mischief his doctrine did, yet I am apt to think, that the grand enemy of God's glory made great use of *Aristotle's* authority and errors, to detract from it.

FOR as *Aristotle*, by introducing the opinion of the eternity of the world, (whereof he owns himself to have been the first broacher) did at least, in almost all men's opinion, openly deny God the production of the world; so, by ascribing the admirable works of God to what he calls nature, he tacitly denies him the government of the world: which suspicion if you judge severe, I shall not, at more leisure, refuse to acquaint you, (in a distinct paper) why I take divers of *Aristotle's* opinions relating to religion to be more unfriendly, not to say pernicious, to it, than those of several other heathen philosophers.

AND here give me leave to prevent an objection, that some may make, as if to deny the received notion of nature, a man must also deny providence, of which nature is the grand instrument. For, in the first place, my opinion hinders me not at all from acknowledging God to be the author of the universe, and the continual preserver and upholder of it; which is much more than the peripatetic hypothesis, which (as we were saying) makes the world eternal, will allow its embracers to admit: and those things, which the school-philosophers ascribe to the agency of nature interposing according to emergencies, I ascribe to the wisdom of God in the first fabric of the universe, which he so admirably contrived, that, if he but continue his ordinary and general concurrence, there will be no necessity of extraordinary interpositions, which may reduce him to seem, as it were, to play after-games; all those exigencies, upon whose account philosophers and physicians seem to have devised what they call nature, being foreseen and provided for in the first fabric of the world; so that mere matter, so ordered, shall, in such and such conjunctures of circumstances, do all, that philosophers ascribe on such occasions to their almost omniscient nature, without any knowledge of what it does, or acting otherwise than according to the catholic laws of motion. And methinks the difference betwixt their opinion of God's agency in the world, and that, which I would propose, may be somewhat adumbrated by saying, that they seem to imagine the world to be after the nature of a puppet, whose contrivance indeed may be very artificial, but yet is such, that almost every particular motion the artificer is fain (by drawing sometimes one wire or string, sometimes another) to guide and oftentimes over-rule the actions of the engine; whereas, according to us, it is like a rare clock, such as may be that at *Strasburgh*, where all things are so skilfully contrived, that the engine being once set a moving, all things proceed, according to the artificer's first design, and the motions of the little statues, that at such hours performs these or those things, do not require, like those of puppets, the peculiar interposing of the artificer, or any intelligent agent employed by him, but perform their functions upon particular occasions, by virtue of the general and primitive contrivance of the whole engine. The modern *Aristotelians* and other philosophers would not be taxed as injurious to providence, though they now ascribe to the ordinary course of nature those regular motions of the planets, that *Aristotle* and most of his followers (and among them the Christian schoolmen) did formerly ascribe to the particular guidance of intelligent and immaterial beings, which they assigned to be the motives

of the cœlestial orbs. And when I consider, how many things, that seem anomalies to us, do frequently enough happen in the world, I think it is more consonant to the respect we owe to divine providence, to conceive, that as God is a most free, as well as a most wise agent, and may in many things have ends unknown to us, he very well foresaw, and thought fit, that such seeming anomalies should come to pass, since he made them (as is evident in the eclipses of the sun and moon) the genuine consequences of the order he was pleased to settle in the world; by whose laws the grand agents in the universe were impowered and determined to act, according to the respective natures he had given them, and the course of things was allowed to run on, though that would infer the happening of seeming anomalies, and things really repugnant to the good or welfare of divers particular portions of the universe: this, I say, I think to be a notion more respectful to divine providence, than to imagine, as we commonly do, that God has appointed an intelligent and powerful Being, called nature, to be, as his vicegerent, continually watchful for the good of the universe in general, and of the particular bodies, that compose it; whilst, in the mean time, this Being appears not to have the skill, or the power, to prevent such anomalies, which oftentimes prove destructive to multitudes of animals, and other noble creatures, (as in plagues, &c.) and sometimes prejudicial to greater portions of the universe, (as in earthquakes of a large spread, eclipses of the luminaries, great and lasting spots on the sun, eruptions of vulcanos, great comets, or new stars, that pass from one region of Heaven to another.) And I am the more tender of admitting such a lieutenant to divine providence, as nature is fancied to be, because I shall hereafter give you some instances, in which it seems, that, if there were such a thing, she must be said to act too blindly and impotently, to discharge well the part she is said to be trusted with.

I SHALL add, that the doctrine I plead for does much better, than its rival, comply with what religion teaches us about the extraordinary and supernatural interpositions of divine providence. For when it pleases God to over-rule, or controul, the established course of things in the world, by his own omnipotent hand, what is thus performed may be much easier discerned and acknowledged to be miraculous by them, that admit, in the ordinary course of corporeal things, nothing but matter and motion, whose powers men may well judge of, than by those, who think there is besides a certain semi-deity, which they call nature, whose skill and power they acknowledge to be exceeding great, and yet have no sure way of estimating, how great they are, and how far they may extend. And give me leave to take notice to you, on this occasion, that I observe the miracles of our Saviour and his Apostles, pleaded by Christians on the behalf of their religion, to have been very differently looked on by Epicurean and other corpuscularian infidels, and by those other unbelievers, who admit of a soul of the world, or spirits in the stars, or, in a word, think the universe to be governed by intellectual beings distinct from the supreme being we call God: for this latter sort of infidels have often admitted those matters of fact, which we Christians call miracles, and yet have endeavoured to solve them by astral operations, and other ways not here to be specified; whereas the Epicurean enemies of Christianity have thought themselves obliged resolutely to deny the matters of fact themselves, as well discerning, that the things said to be performed exceeded the mechanical powers of matter and motion, (as they were managed by those, that wrought the miracles,) and consequently must either be denied to have been done, or be confessed to have been truly miraculous. But there may hereafter be occasion, both to improve the things already said, and add others, to satisfy theological scruples about our hypothesis.

I FORMERLY told you, that it was not only to the glory of God, (as that results from his wisdom, power and goodness, expressed in the world) that I suspected the notion

See the III, the IV, and also the last Section of this Treatise.

notion of nature, that I am examining, to be prejudicial, but also to the discovery of his works. And you will make no great difficulty to believe me, if you consider, that, whilst men allow themselves so general and easy a way of rendering accounts of things, that are difficult, as to attribute them to nature, shame will not reduce them to a more industrious scrutiny into the reasons of things, and curiosity itself will move them to it the more faintly: of which we have a clear and eminent example in the ascension of water in pumps, and in other phænomena of that kind, whose true physical causes had never been found out, if the moderns had acquiesced, as their predecessors did, in that imaginary one, that the world was governed by a watchful being, called nature, and that she abhors a vacuum, and consequently is still in a readiness to do irresistibly whatever is necessary to prevent it; nor must we expect any great progress in the discovery of the true causes of natural effects, whilst we are content to sit down with other, than the particular and immediate ones.

It is not, that I deny, that there are divers things, as the number and situation of the stars, the shapes and sizes of animals, &c. about which even a philosopher being asked can say little, but that it pleased the author of the universe to make them so; but when we give such general answers, we pretend not to give the particular physical reasons of the things proposed, but do in effect confess we do not know them. To this I add, that the veneration, wherewith men are imbued for what they call nature, has been a discouraging impediment to the empire of man over the inferior creatures of God: for many have not only looked upon it, as an impossible thing to compass, but as something of impious to attempt, the removing of those boundaries, which nature seems to have put and settled among her productions; and whilst they look upon her as such a venerable thing, some make a kind of scruple of conscience to endeavour so to emulate any of her works, as to excel them.

I HAVE staid so long about removing the first of the two scruples I formerly proposed against my present attempt, that, not to tire your patience, I shall in few words dispatch the second; which is, that I venture to contradict the sense of the generality of mankind: to which I answer, that in philosophical inquiries, it becomes not a naturalist to be so solicitous, what has been, or is believed, as what ought to be so; and I have also elsewhere, on another occasion, shewed, how little the sense of the generality of men ought to sway us in some questions. But that, which I shall at present more directly reply, is, first, that it is no wonder men should be generally prepossessed with such a notion of nature, as I call in question, since education (especially in schools) has imbued them with it from their infancy, and even in their maturer years they find it taken for granted, and employed not only by the most but by the learnedest writers, and never hear it called in question by any: and then it exceedingly complies with our innate propensity to think, that we know more than we do, and to appear to do so; for to vouch nature for a cause, is an expedient, that can scarce be wanting to any man, upon any occasion, to seem to know, what he can indeed render no good reason of.

AND to this first part of my answer, I shall subjoin this second: that the general custom of mankind to talk of a thing as a real and positive being, and attribute great matters to it, does but little weigh with me, when I consider, that, though fortune be not any physical thing, but a certain loose and undetermined notion, which a modern metaphysician would refer to the classis of his non entia; yet not only the Gentiles made it a Goddess,

(*Nos te facimus, fortuna, deam, cœloque locamus.*)

which many of them seriously worshipped, but eminent writers, in verse and in prose, ethnick

ethnick and Christian, antient and modern, and all sorts of men in their common discourse, do seriously talk of it, as if it were a kind of Antichrist, that usurped a great share in the government of the world, and ascribe little less to it, than they do to nature. And not to speak of what poets, moralists and divines tell us of the powers of ignorance and vice, which are but moral defects, let us consider, what things are not only by these men, but by the generality of mankind, seriously attributed to death, to which so great and fatal a dominion is assigned; and then if we consider too, that this death, which is said to do so many and such wonderful things, is neither a substance, nor a positive entity, but a meer privation; we shall, I trust, the less believe, that the feats ascribed to nature do infer, that there is really such a physical agent, as is supposed.

AND now having, as I presume, cleared our inquiry, as far as it is yet necessary, [and it will be further done hereafter] from those prejudices, that might make the attempt be censured before it be examined, I proceed to the inquiry itself; wherein I shall endeavour (but with the brevity my want of leisure exacts) to do these six things. *First*, to give you a short account of the great ambiguity of the word nature, arising from its various acceptions. *Secondly*, to shew you, that the definition also, that *Aristotle* himself gives of nature, does not afford a clear or satisfactory notion of it. *Thirdly*, to gather from the several things, that are wont to be affirmed of, or attributed to, nature, the received notion of it, which cannot be well gathered from the name, because of its great ambiguity. *Fourthly*, I will mention some of those reasons, that dissuade me from admitting this notion of nature. *Fifthly*, I shall endeavour to answer severally the chief things, upon which men seem to have taken up the idea of nature, that I disallow. And, *Sixthly*, I shall propose some of the chief *effata* or axioms, that are wont to be made use of, concerning nature in general, and shall shew, how far, and in what sense, I may admit them.

AND here it may be opportune, to prevent both mistakes and the necessity of interrupting the series of our discourse, to set down two or three advertisements.

1. WHEN any where in this tract I speak of the opinion of *Aristotle* and the Peripatetics, as I would not be thought to impute to him all the sentiments of those, that will be thought his followers, some of which seem to me to have much mistaken his true meaning so (on the other side) I did not conceive, that my design obliged me to inquire anxiously into his true sentiments, whether about the origin of the universe, (as whether or no it were self-existent, as well as eternal) or about less important points: since, besides that his expressions are oftentimes dark and ambiguous enough, and the things he delivers in several passages do not seem always very consistent; it sufficed for my purpose, which was to question vulgar notions, to examine those opinions, that are by the generality of scholars taken for the *Aristotelian* and Peripatetic doctrines, by which, if he be misrepresented, the blame ought to light upon his commentators and followers.

2. THE rational soul or mind of man, as it is distinct from the sensitive soul, being an immaterial spirit, is a substance of so heteroclite a kind, in reference to things so vastly differing from it, as mere bodies are, that since I could neither, without injuring it, treat of it promiscuously with the corporeal works of God, nor speak worthily of it, without frequently interrupting and disordering my discourse by exceptions, that would either make it appear intricate, or would be very troublesome to you or any other, that you may think fit to make my reader; I thought I might, for others ease and my own, be allowed to set aside the considerations of it in the present treatise; and the rather, because all other parts of the universe being, according to
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the received opinion, the works of nature, we shall not want in them subjects more than sufficiently numerous, whereon to make our examen; though I shall here consider the world but as the great system of things corporeal, as it once really was towards the close of the sixth day of the creation, when God had finished all his material works, but had not yet created man.

S E C T. II.

I. **A** CONSIDERING person may well be tempted to suspect, that men have generally had but imperfect and confused notions concerning nature; if he but observes, that they apply that name to several things, and those to such, as have some of them very little dependance on, or connexion with, such others. And I remember, that in *Aristotle's* *Metaphysics*, I met with a whole chapter expressly written to enumerate the various acceptions of the Greek word, φύσις, commonly rendered nature; of which, if I mistake not, he there reckons up six. In *English* also we have not fewer, but rather more numerous significations of that term: for sometimes we use the word nature for that author of nature, whom the schoolmen harshly enough call *natura naturans*; as when it is said, that nature hath made man partly corporeal, and partly immaterial. Sometimes we mean by the nature of a thing, the essence, or that, which the schoolmen scruple not to call the quiddity of a thing, namely, the attribute or attributes, on whose score it is, what it is, whether the thing be corporeal or not; as, when we attempt to define the nature of an angle, or of a triangle, or of a fluid body, as such. Sometimes we confound that, which a man has by nature, with what accrues to him by birth; as, when we say, that such a man is noble by nature, or such a child naturally forward, or sickly, or frightful. Sometimes we take nature for an internal principle of motion; as, when we say, that a stone let fall in the air is by nature carried towards the centre of the earth; and, on the contrary, that fire or flame does naturally move upwards towards heaven.

SOMETIMES we understand by nature the established course of things; as, when we say, that nature makes the night succeed the day; nature hath made respiration necessary to the life of men.

SOMETIMES we take nature for an aggregate of powers belonging to a body, especially a living one; as, when physicians say, that nature is strong, or weak, or spent; or that in such or such diseases, nature left to herself will do the cure. Sometimes we take nature for the universe, or system of the corporeal works of God; as, when it is said of a phoenix, or a chimera, that there is no such thing in nature, (*i. e.*) in the world. And sometimes too, and that most commonly, we would express by the word nature a semi-deity, or other strange kind of being, such as this discourse examines the notion of. And besides these more absolute acceptions, if I may so call them, of the word nature, it has divers others, (more relative,) as nature is wont to be set in opposition or contradistinction to other things; as when we say of a stone, when it falls downwards, that it does it by a natural motion; but that if it be thrown upwards, its motion that way is violent. So chymists distinguish vitriol into natural, and factitious, or made by art, (*i. e.*) by the intervention of human power or skill: so it is said, that water, kept suspended in a sucking pump is not in its natural place, as that is, which is stagnant in the well. We say also, that wicked men are still in a state of nature, but the regenerate in a state of grace: that cures, wrought by medicines, are natural operations; but the miraculous ones, wrought by Christ and his apostles, were supernatural. Nor are these the only forms of speech, that a more diligent collector, than I think it necessary I should here be, might instance in,

to manifest the ambiguity of the word nature, by the many and various things it is applied to signify, though some of those already mentioned should be judged too near to be co-incident. Among *Latin* writers I found the acceptions of the word nature to be so many, that I remember one author reckons up no less than fourteen or fifteen. From all which it is not difficult to gather, how easy it is for the generality of men, without excepting those, that write of natural things, to impose upon others and themselves, in the use of a word so apt to be misemployed.

ON this occasion I can scarce forbear to tell you, that I have often looked upon it as an unhappy thing, and prejudicial both to philosophy and physick, that the word nature hath been so frequently, and yet so unskilfully employed, both in books and in discourse, by all sorts of men, learned and illiterate. For the very great ambiguity of this term, and the promiscuous use men are wont to make of it, without sufficiently attending to its different significations, makes many of the expressions, wherein they employ it, (and think they do it well and truly) to be either not intelligible, or not proper, or not true: which observation, though it be not heeded, may, with the help of a little attention, be easily verified; especially because the term nature is so often used, that you shall scarce meet with any man, who, if he have occasion to discourse any thing long of either natural or medicinal subjects, would not find himself at a great loss, if he were prohibited the use of the word nature, and of those phrases, whereof it makes the principal part. And I confess I could heartily wish, that philosophers, and other learned men (whom the rest in time would follow) would by common (though perhaps tacit) consent, introduce some more significant, and less ambiguous terms and expressions in the room of the too licentiously abused word nature, and the forms of speech, that depend on it; or would, at least, decline the use of it, as much as conveniently they can; and where they think they must employ it, would add a word or two, to declare in what clear and determinate sense they use it. For without somewhat of this kind be done, men will very hardly avoid being led into divers mistakes, both of things, and of one another; and such wranglings about words and names will be (if not continually multiplied) still kept on foot, as are wont to be managed with much heat, though little use, and no necessity.

AND here I must take leave to complain, in my own excuse, of the scarce superable difficulty of the task, that the design of a free inquiry puts me upon. For it is far more difficult, than any one, that hath not tried, (and I do not know that any man hath,) would imagine, to discourse long of the corporeal works of God, and especially of the operations and phænomena, that are attributed to nature, and yet decline making oftentimes use of that term, or forms of speech, whereof it is a main part, without much more frequent, and perhaps tedious, circumlocutions, than I am willing to trouble you with. And therefore I hope you will easily excuse me, if, partly to shun these, and to avoid using often the same words too near one another, and partly out of unwillingness to employ vulgar terms likely to occasion or countenance vulgar errors; I have several times been fain to use paraphrases, or other expressions, less short than those commonly received; and sometimes for one or other of these reasons or out of inadvertence, missed of avoiding the terms used by those, that admit and applaud the vulgar notion of nature; whom, I must here advertise you, that partly because they do so, and partly for brevity's sake, I shall hereafter many times call naturists: which appellation I rather chuse than that of naturalists, because many, even of the learned among them, as logicians, orators, lawyers, arithmeticians, &c. are not physiologists.

BUT if on this occasion you should be very urgent to know, what course I would think expedient, if I were to propose any, for the avoiding the inconvenient use of so ambiguous

ambiguous a word, as nature; I should first put you in mind, that having but very lately declared, that I thought it very difficult, in physiological discourses especially, to decline the frequent use of that term, you are not to expect from me the satisfaction you may desire in an answer; and then I would add, that yet my unwillingness to be altogether silent, when you require me to say somewhat, makes me content to try, whether the mischief complained of may not be in some measure either obviated or lessened, by looking back upon the (eight) various significations, that were not long since delivered of the word nature, and by endeavouring to express them in other terms, or forms of speech.

1. INSTEAD then of the word nature, taken in the first sense, [for *natura naturans*,] we may make use of the term it is put to signify, namely, God; wholly discarding an expression, which, besides that it is harsh and needless, and in use only among the schoolmen, seems not to me very suitable to the profound reverence we owe the divine majesty; since it seems to make the creator differ too little by far from a created (not to say an imaginary) Being.

2. INSTEAD of nature in the second sense, [for, *That, on whose account a thing is what it is, and is so called*,] we may employ the word essence, which is of great affinity to it, if not of an adequate import: and sometimes also we may make use of the word quiddity, which, though a somewhat barbarous term, is yet frequently employed, and well enough understood, in the schools; and, which is more considerable, is very comprehensive, and yet free enough from ambiguity.

3. WHAT is meant by the word nature taken in the third sense of it, [for *what belongs to a living creature at its nativity, or accrues to it by its birth*,] may be expressed sometimes by saying, that a man or other animal is born so; and sometimes by saying, that a thing has been generated such; and sometimes also, that it is thus or thus qualified by its original temperament and constitution.

4. INSTEAD of the word nature taken in the fourth acception [for, an *internal principle of local motion*] we may say sometimes, that this or that body moves as it were, or else that it seems to move, spontaneously (or of its own accord) upwards, downwards, &c. or, that is put into this or that motion, or determined to this or that action by the concurrence of such or such (proper) causes.

5. FOR nature in the fifth signification, (for, the *established course of things corporeal*) it is easy to substitute what it denotes, *the established order, or the settled course of things*.

6. INSTEAD of nature in the sixth sense of the word [for, an *aggregate of the powers belonging to a body, especially a living one*] we may employ the constitution, temperament, or the mechanism, or the complex of the essential properties or qualities; and sometimes the condition, the structure, or the texture of that body: and if we speak of the greater portions of the world, we may make use of one or other of these terms, *Fabric of the world, system of the universe, cosmical mechanism, or the like*.

7. WHERE men are wont to employ the word nature in the seventh sense [for the *universe, or the system of the corporeal works of God*] it is easy, and as short, to make use of the word world or universe, and instead of the phænomena of nature, to substitute the phænomena of the universe, or of the world.

8. AND, as for the word nature taken in the eighth and last of the fore-mentioned acceptions [for, either (as some Pagans stiled her) a goddess, or a kind of semi-deity] the best way is not to employ it in that sense at all, or at least as seldom as may be; and that for divers reasons, which may in due place be met with in several parts of this essay.

BUT though the foregoing diversity of terms and phrases may be much increased, yet I confess it makes but a part of the remedy I propose against the future mischiefs of the confused acception of the word nature, and the phrases grounded on it. For besides the synonymous words, and more literal interpretations lately proposed, a dexterous writer may oftentimes be able to give such a form (or, as the modern *Frenchmen* speak, such a tour) to his many-ways variable expressions, as to avoid the necessity of making use of the word nature; or sometimes so much as of those shorter terms, that have been lately substituted in its place. And to all this I must add, that though one or two of the eight fore-mentioned terms or phrases, as quiddity and cosmical mechanism, be barbarous or ungentle, and some other expressions be less short than the word nature; yet it is more the interest of philosophy to tolerate a harsh term, that has been long received in the schools in a determinate sense, and bear with some paraphrastical expressions, than not to avoid an ambiguity, that is liable to such great inconveniencies, as have been lately, or may be hereafter, represented.

THERE are, I know, some learned men, who, (perhaps being startled to find nature usually spoken of so much like a kind of goddess,) will have the nature of every thing to be only the law, that it receives from the creator, and according to which it acts on all occasions. And this opinion seems much of kin to, if not the same with that of the famous *Helmont*, who, justly rejecting the *Aristotelian* tenet of the contrariety or hostility of the elements, will have every body, without any such respect, to act that, which it is commanded to act. And indeed this opinion about nature, though neither clear nor comprehensive enough, seems capable of a fair construction. And there is oftentimes some resemblance between the orderly and regular motions of inanimate bodies, and the actions of agents, that, in what they do, act conformably to laws. And even I sometimes scruple not to speak of the laws of motion and rest, that God has established among other things corporeal, and now and then, (for brevity's sake, or out of custom) to call them, as men are wont to do, the laws of nature; having in due place declared, in what sense I understand and employ these expressions.

BUT to speak strictly, (as becomes philosophers, in so weighty a matter) to say, that the nature of this or that body is but *the law of God prescribed to it*, is but an improper and figurative expression: for, besides that this gives us but a very defective idea of nature, since it omits the general fabric of the world, and the contrivances of particular bodies, which yet are as well necessary, as local motion itself, to the production of particular effects and phænomena; besides this, I say, and other imperfections of this notion of nature, that I shall not here insist on, I must freely observe, that, to speak properly, a law being but a *notional rule of acting according to the declared will of a superior*, it is plain, that nothing but an intellectual Being can be properly capable of receiving and acting by a law. For if it does not understand, it cannot know what the will of the legislator is; nor can it have any intention to accomplish it, nor can it act with regard to it, or know when it does, in acting, either conform to it or deviate from it: and it is intelligible to me, that God should at the beginning impress determinate motions upon the parts of matter, and guide them, as he thought requisite, for the primordial constitution of things; and that ever since he should, by his ordinary and general concurrence, maintain those powers, which he gave the parts of matter, to transmit their motion thus and thus to one another. But I cannot conceive, how a body devoid of understanding and sense, truly so called, can moderate and determinate its own motions, especially so, as to make them conformable to laws, that it has no knowledge or apprehension of; and that inanimate bodies,
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how strictly soever called natural, do properly act by laws, cannot be evinced by their sometimes acting regularly, and, as men think, in order to determinate ends: since in artificial things we see many motions very orderly performed, and with a manifest tendency to particular and pre-designed ends; as in a watch, the motions of the spring, wheels, and other parts, are so contempered and regulated, that the hand upon the dial moves with a great uniformity, and seems to moderate its motion so, as not to arrive at the points, that denote the time of the day, either in a minute sooner, or a minute later, than it should do, to declare the hour. And when a man shoots an arrow at a mark, so as to hit it, though the arrow moves towards the mark, as it would if it could and did design to strike it, yet none will say, that this arrow moves by a law, but by an external, though well directed, impulse.

S E C T. III.

II. **B**UT possibly the definition of a philosopher may exempt us from the perplexities, to which the ambiguous expressions of common writers expose us. I therefore thought fit to consider, with a somewhat more than ordinary attention, the famous definition of nature, that is left us by *Aristotle*, which I shall recite rather in *Latin* than in *English*, not only because it is very familiarly known among scholars in that language, but because there is somewhat in it, that I confess seems difficult to me to be without circumlocution rendered intelligibly in *English*: *Natura* (says he) *est principium & causa motus & quietis ejus, in quo inest, primo per se, & non secundum accidens.* ^{2 Phys. c. 1. l. 36} But though when I considered, that according to *Aristotle*, the whole world is but a system of the works of nature, I thought it might well be expected, that the definition of a thing, the most important in natural philosophy, should be clearly and accurately delivered; yet to me this celebrated definition seemed so dark, that I cannot brag of any assistance I received from it towards the framing of a clear and satisfactory notion of nature. For I dare not hope, that what, as to me, is not itself intelligible, should make me understand what is to be declared or explicated by it. And when I consulted some of *Aristotle's* interpreters upon the sense of this definition, I found the more considerate of them so puzzled with it, that their discourses of it seemed to tend rather to free the maker of it from tautology and self-contradiction, than to manifest, that the definition itself is good and instructive, and such as affords a fair account of the thing defined. And indeed, though the immoderate veneration they cherish for their master engages them to make the best they can of the definition given to him, even when they cannot justify it without strained interpretations, yet what every one seems to defend in gross, almost every one of them censures in parcels; this man attacking one part of the definition, and that man another, with objections so weighty, (not to call some of them unanswerable) that if I had no other arguments to urge against it, I might borrow enough from the commentators on it to justify my dislike of it.

HOWEVER, we may hereafter have occasion to consider some of the main parts of this definition, and in the mean while it may suffice, that we observe, that several things are commonly received, as belonging to the idea or notion of nature, that are not manifestly, or not at all, comprehended in this *Aristotelian* definition, which doth not declare, whether the principle or cause (which expression already makes the sense doubtful) here mentioned is a substance, or an accident; and if a substance, whether corporeal or immaterial: nor is it clearly contained in this definition, that nature does all things most wisely, and still acts by the most compendious ways without ever missing of her end; and that she watches against a vacuum for the welfare of the uni-

verse ; to omit divers other things, that you will find ascribed to her in the following section, to which I now proceed.

THAT the great shortness of this third section may not make it too disproportionate in length to the others this tract consists of, I shall in this place, though I doubt it be not the most proper, that could be chosen, endeavour to remove betimes the prejudice, that some divines and other pious men may perhaps entertain, upon the account, as they think, of religion, against the care I take, to decline the frequent use of that word nature, in the vulgar notion of it ; reserving to another and fitter place some other things, that may relate to the theological scruples, if any occur to me, that our free inquiry may occasion.

THE philosophical reason, that inclines me to forbear, as much as conveniently I can, the frequent use of the word nature, and the forms of speech, that are derived from it is, that it is a term of great ambiguity : on which score I have observed, that being frequently and unwarily employed, it has occasioned much darkness and confusion in many men's writings and discourses. And I little doubt, but that others would make the like observations, if early prejudices and universal custom did not keep them from taking notice of it.

NOR do I think myself obliged, by the just veneration I owe and pay religion, to make use of a term so inconvenient to philosophy. For I do not find, that for many ages the *Israelites*, that then were the only people and church of God, made use of the word nature in the vulgar notion of it. *Moses* in the whole history of the creation, where it had been so proper to bring in this first of second causes, has not a word of nature : and whereas philosophers presume, that she, by her plastic power and skill, forms plants and animals out of the universal matter, the divine historian ascribes the formation of them to God's immediate fiat, *Gen. i. 11. And God said, let the earth bring forth grass, and the herb yielding seed, and the fruit tree yielding fruit after his kind, &c.* And again, *ver. 24. God said, let the earth bring forth the living creature after its kind, &c. ver. 25. And God (without any mention of nature) made the beast of the earth after his kind.* And I do not remember, that in the *Old Testament*, I have met with any one Hebrew word, that properly signifies nature, in the sense we take it in. And it seems, that our English translators of the Bible were not more fortunate in that, than I ; for having purposely consulted a late concordance, I found not that word nature in any text of the *Old Testament*. So likewise, though *Job*, *David*, and *Solomon*, and other *Israelitish* writers, do, on divers occasions, many times mention the corporeal works of God, yet they do not take notice of nature, which our philosophers would have his great vicergerent in what relates to them. To which perhaps it may not be impertinent to add, that though the late famous *Rabbi Menasseh Ben Israel* has purposely written a book of numerous problems touching the creation ; yet I do not remember, that he employs the word nature, in the received notion of it, to give an account of God's mundane creatures. And when *St. Paul* himself, who was no stranger to the Heathen learning, writing to the *Corinthians*, who were *Greeks*, speaks of the production of corn out of seed sown, he does not attribute the produced body to nature ; but when he had spoken of a grain of wheat, or some other seed put into the ground ; he adds, that *God gives it such a body as he pleaseth, and to every seed its own body, i. e.* And a greater than *St. Paul*, speaking of the gaudineis of the lillies, (or as some will have it, tulips,) uses this expression, *If God so clothe the grass of the field, &c. Matt. vi. 28, 29, 30.* The celebrations, that *David*, *Job*, and other holy *Hebrews*, mentioned in the *Old Testament*, make on occasion of the admirable works they contemplated in the universe, are addressed directly to God himself, without

without taking notice of nature. Of this I could multiply instances, but shall here, for brevity's sake, be contented to name a few, taken from the book of *Psalms* alone. In the hundredth of those hymns, the penman of it makes this, *That God has made us*, the ground of an exhortation, *To enter into his gates with thanksgiving, and into his courts with praise*, *Psal.* lxxix. 34. And in another, *Let the heaven and earth praise God*, [that is, give men ground and occasion to praise Him] congruously to what *David* elsewhere says to the great creator of the universe, *All thy works shall praise thee, O Lord, and thy saints shall bless thee*, *Psal.* cxlv. 10. And in another of the sacred hymns, the same royal poet says to his maker, *Thou hast covered me in my mother's womb. I will praise thee, for I am fearfully and wonderfully made; marvellous are thy works, and that my soul knoweth right well*, *Psal.* cxxxix. 13, 14.

I HAVE sometimes doubted, whether one may not on this occasion add, that if men will needs take in a Being subordinate to God, for the management of the world; it seems more consonant to the holy scripture, to depute angels to that charge, than nature. For I consider, that, as to the celestial part of the universe, in comparison of which the sublunary is not perhaps the ten thousandth part, both the heathen *Aristotelians*, and the school philosophers among the Christians, teach the celestial orbs to be moved or guided by intelligences, or angels. And as to the lower or sublunary world, besides that the holy writings teach us, that angels have been often employed by God for the government of kingdoms, (as is evident out of the book of *Daniel*) and the welfare and punishment of particular persons; one of those glorious spirits is in the apocalypse, expressly styled *the angel of the waters*: which title divers learned interpreters think to be given him, because of his charge or office to oversee and preserve the waters. And I remember, that in the same book there is mention made of an angel, that had *power, authority, or jurisdiction*, (*ἐξουσία*) *over the fire*. And though the excellent *Grotius* gives another conjecture of the title given the *angel of the waters*; yet in his notes upon the next verse save one, he teaches, that there was an angel appointed to preserve the souls, that were kept under the altar there mentioned. And if we take the *angel of the waters* to be the guardian or conservator of them, perhaps as the *Romans* (in whose empire *St. John* wrote) had special officers to look to their aqueducts and other waters; it may not be amiss to observe upon the by, that he is introduced praising his and his fellow-spirits great creator: which is an act of religion, that, for aught I know, none of the naturists, whether Pagan or even Christians, ever mentioned their nature to have performed.

I KNOW it may on this occasion be alledged, that *subordinata non pugnant*, and nature being God's vicegerent, her works are indeed his. But that he has such a vicegerent, it is one of the main businesses of this discourse to call in question; and till the affirmative be solidly proved, (nay, and though it were so) I hope I shall be excused, if with *Moses*, *Job*, and *David*, I call the creatures I admire in the visible world, the works of God, (not of nature) and praise rather him than her, for the wisdom and goodness displayed in them; since among the *Israelites*, till they were overrun and corrupted by idolatrous nations, there was for many ages a deep silence of such a being, as we now call nature. And I think it much more safe and fit, to speak as did those, who for so long a time were the peculiar people of God, than with the heathen poets and philosophers, who were very prone to ascribe divinity to his creatures, and sometimes even to their own.

I MENTION these things, not with design to engage in the controversy, about the authority or use of the scripture in physical speculations, but to obviate or remove a prejudice, that (as I formerly intimated) I fear may be taken up, upon the account of theology or religion, against my studiously unfrequent employing the word nature.

in the vulgar sense of it; by shewing, that, whether or no the scriptures be not designed to teach us higher and more necessary truths than those, that concern bodies, and are discoverable by the meer light of reason, both its expressions and its silence give more countenance to our hypothesis, than to that of the naturists.

S E C T. IV.

III. **H**AVING shewn, that the definition given of nature by *Aristotle* himself, as great a logician as he was, has not been able to satisfy so much as his interpreters and disciples, what his own idea of nature was, it would be to little purpose to trouble you and myself with inquiring into the definitions and disputes of other Peripatetics, about so obscure and perplexed a subject; especially since it is not my business in this tract solicitously to examine, what *Aristotle* thought nature to be, but what is to be thought of the vulgarly received notion of nature: and though of this the schools have been the chief propagators, for which reason it was fit to take notice of their master *Aristotle's* definition; yet the best way, I know, to investigate the commonly received opinion of nature, is, to consider, what effata or axioms do pass for current about her; and what titles and epithets are unanimously given her, both by philosophers and other writers, and by the generality of men, that have occasion to discourse of her and her actings.

Of these axioms and epithets, the principal seem to be these, that follow.

Natura est sapientissima, adeoque opus naturæ est opus intelligentiæ.

* *Natura nihil facit frustra.*

Natura sine suo nunquam excidit.

† *Natura semper facit quod optimum est.*

Natura semper agit per vias brevissimas.

Natura neque redundat in superfluis, neque deficit in necessariis.

Omnis natura est conservatrix sui.

Natura est morborum medicatrix.

Natura semper invigilat conservationi universi.

Natura vacuum horret.

FROM all these particulars put together, it may appear, that the vulgar notion of nature may be conveniently enough expressed by some such description as this:

NATURE is a most wise being, that does nothing in vain; does not miss of her ends; does always that, which (of the things she can do) is best to be done; and this she does by the most direct or compendious ways, neither employing any things superfluous, nor being wanting in things necessary; she teaches and inclines every one of her works to preserve itself: and, as in the microcosm, (man) it is she, that is the curer of diseases; so in the macrocosm (the world) for the conservation of the universe, she abhors a vacuum, making particular bodies act contrary to their own inclinations and interests, to prevent it, for the public good.

WHAT I think of the particulars, that make up this panegyric description of nature, will (God permitting) be told you in due place; my present work being only to make you the clearest representation I can, of what men generally (if they understand themselves) do, or, with congruity to the axioms they admit and use, ought to conceive nature to be.

It is not unlike, that you may expect or wish, that on this occasion, I should propose some definition or description of nature, as my own. But declining (at least at present) to say any thing dogmatically about this matter, I know not, whether I may

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not, on this occasion, confess to you, that I have sometimes been so paradoxical, or (if you please) so extravagant, as to entertain, as a serious doubt, what I formerly intimated, *viz.* whether nature be a thing, or a name? I mean, whether it be a real existent being, or a notional entity, somewhat of kin to those fictitious terms, that men have devised, that they might compendiously express several things together by one name? As when, for instance, we speak of the concocting faculty ascribed to animals, those, that consider, and are careful to understand what they say, do not mean, I know not what entity, that is distinct from the human body, as it is an engine curiously contrived, and made up of stable and fluid parts; but observing an actuating power and fitness in the teeth, tongue, spittle, fibres and membranes of the gullet and stomach, together with the natural heat, the ferment, or else the menstruum, and some other agents, by their co-operation, to cook or dress the aliments, and change them into chyle; observing these things, I say, they thought it convenient, for brevity's sake, to express the complex of those causes, and the train of their actions, by the summary appellation of concocting faculty.

WHILST I was indulging myself in this kind of ravings, it came into my mind, that the naturalists might demand of me, how, without admitting their notion, I could give any tolerable account of those most useful forms of speech, which men employ, when they say, that nature does this or that; or, that such a thing is done by nature, or according to nature, or else happens against nature? And this question I thought the more worth answering, because these phrases are so frequently used by men of all sorts, as well learned as illiterate, that this custom hath made them be thought not only very convenient, but necessary; insomuch that I look upon it as none of the least things, that has procured so general a reception to the vulgar notion of nature, that these ready and commodious forms of speech suppose the truth of it.

It may, therefore, in this place, be pertinent to add, that such phrases, as, that nature, or faculty, or suction, doth this or that, are not the only ones wherein I observe, that men ascribe to a notional thing that, which, indeed, is performed by real agents; as, when we say, that the law punishes murder with death, that it protects the innocent, releases a debtor out of prison, when he has satisfied his creditors (and the ministers of justice), on which, or the like occasions, we may justly say, that it is plain, that the law, which, being in itself a dead letter, is but a notional rule, cannot, in a physical sense, be said to perform these things; but they are really performed by judges, officers, executioners, and other men, acting according to that rule. Thus when we say, that custom does this or that, we ought to mean only, that such things are done by proper agents, acting with conformity to what is usual, (or customary) on such occasions. And, to give you a yet more apposite instance, do but consider, how many events are wont to be ascribed to fortune or chance; and yet fortune is, in reality, no physical cause of any thing, (for which reason probably it is, that ancienter naturalists than *Aristotle*, as himself intimates, take no notice of it, when they treat of natural causes) and only denotes, that those effects that are ascribed to it, were produced by their true and proper agents, without intending to produce them; as, when a man shoots at a deer, and the arrow lightly glancing upon the beast wounds some man, that lay beyond him, unseen by the archer; it is plain, that the arrow is a physical agent, that acts by virtue of its fabric and motion, in both these effects; and yet men will say, that the slight hurt it gave the deer, was brought to pass according to the course of nature, because the archer designed to shoot the beast; but the mortal wound it gave the man happened by chance, because the archer intended not to shoot him, or any man else. And whereas divers of the old atomical philosophers,

losophers, pretending (without good reason, as well as against piety) to give an account of the origin of things, without recourse to a Deity, did sometimes affirm the world to have been made by nature, and sometimes by fortune, promiscuously employing those terms; they did it, (if I guess aright) because they thought neither of them to denote any true and proper physical cause, but rather certain conceptions, that we men have of the manner of acting of true and proper agents. And therefore, when the Epicureans thought the world to have been made by chance, it is probable, that they did not look upon chance as a true and architectonic cause of the system of the world, but believed all things to have been made by the atoms, considered as their conventions and concretions into the sun, stars, earth, and other bodies, were made without any design of constituting those bodies.

WHILST this vein of framing paradoxes yet continued, I ventured to proceed so far, as to question, whether one may not infer, from what has been said, that the chief advantage a philosopher receives from what men call nature, be not, that it affords them, on divers occasions, a compendious way of expressing themselves? since (thought I) to consider things otherwise than in a popular way, when a man tells me, that nature does such a thing, he does not really help me to understand, or to explicate, how it is done; for it seems manifest enough, that whatever is done in the world, at least wherein the rational soul intervenes not, is really effected by corporeal causes and agents, acting in a world so framed as ours is, according to the laws of motion settled by the omniscient Author of things.

WHEN a man knows the contrivance of a watch or clock, by viewing the several pieces of it, and seeing how, when they are duly put together, the spring or weight sets one of the wheels a working; and by that another, till by a fit consecution of the motions of these and other parts, at length the index comes to point at the right hour of the day; the man, if he be wise, will be well enough satisfied with this knowledge of the cause of the proposed effect, without troubling himself to examine, whether a notional philosopher will call the time-measuring instrument an *ens per se*, or an *ens per accidens*? and whether it performs its operations by virtue of an internal principle, such as the spring of it ought to be? or of an external one, such as one may think the appended weight? And, as he that cannot, by the mechanical affections of the parts of the universal matter, explicate a phenomenon, will not be much helped to understand, how the effect is produced, by being told, that nature did it: so, if he can explain it mechanically, he has no more need to think, or (unless for brevity's sake) to say, that nature brought it to pass, than he, that observes the motions of a clock, has to say, that it is not the engine, but it is art, that shews the hour; whereas, without considering that general and uninstruative name, he sufficiently understands, how the parts, that make up the engine, are determined by their construction, and the series of their motions, to produce the effect that is brought to pass.

WHEN the lower end of a reed, being dipped, for instance, in milk or water, he that holds it, does cover the upper end with his lips, and fetches his breath, and hereupon the liquor flows into his mouth; we are told, that nature raiseth it to prevent a vacuum, and this way of raising it, is called suction: but, when this is said, the word nature does but furnish us with a short term, to express a concurrence of several causes, and so does in other cases, but what the word suction does in this; for neither the one, nor the other, helps us to conceive, how this seemingly spontaneous ascension of a heavy liquor is effected; which they that know, that the outward air is a heavy fluid, and gravitates, or presses more upon the other parts of the liquor, than the air contained in the reed (which is rarefied by the dilatation of the sucker's

sucker's thorax) does upon the included part of the surface, will readily apprehend, that the smaller pressure will be surmounted by the greater, and consequently yield to the ascension of the liquor, which is, by the prevalent external pressure, impelled up into the pipe, and so into the mouth, (as I, among others, have elsewhere made out.) So that, according to this doctrine, without recurring to nature's care, to prevent a vacuum, one, that had never heard of the Peripatetic notions of nature, or of suction, might very well understand the mentioned phenomenon. And, if afterwards he should be made acquainted with the received opinions, and forms of speech, used on this occasion, he would think, that so to ascribe the effect to nature is needless, if not also erroneous; and that the common theory of suction can afford him nothing, but a compendious term, to express, at once, the concurrence of the agents, that make the water ascend.

How far I think these extravagant reasonings may be admitted, you may be enabled to discern, by what you will hereafter meet with, relating to the same subjects, in the seventh section of this discourse. And therefore, returning now to the rise of this digression, namely, that it is not unlike you may expect, I should, after the vulgar notion of nature, that I lately mentioned, without acquiescing in it, substitute some definition or description of nature, as mine; I hope you will be pleased to remember, that the design of this paper was, to examine the vulgar notion of nature, not propose a new one of my own. And indeed the ambiguity of the word is so great, and it is, even by learned men, usually employed to signify such different things, that, without enumerating and distinguishing its various acceptations, it were very unsafe to give a definition of it, if not impossible to deliver one, that would not be liable to censure. I shall not therefore presume to define a thing, of which there is yet no settled and stated notion agreed on among men: and yet, that I may, as far as I dare, comply with your curiosity, I shall tell you, that if I were to propose a notion, as less unfit, than any I have met with, to pass for the principal notion of nature, with regard to which many axioms and expressions, relating to that word, may be not inconveniently understood, I should distinguish between the universal, and the particular nature of things. And, of universal nature, the notion I would offer should be some such as this; that nature is the aggregate of the bodies, that make up the world, framed as it is, considered as a principle, by virtue whereof they act and suffer, according to the laws of motion prescribed by the Author of things. Which description may be thus paraphrased; that nature, in general, is the result of the universal matter, or corporeal substance of the universe, considered as it is contrived in the present structure and constitution of the world, whereby all the bodies, that compose it, are enabled to act upon, and fitted to suffer from one another, according to the settled laws of motion. I expect, that this description will appear prolix, and require to be heedfully perused; but the intricateness and importance of the subject hindered me from making it shorter, and made me chuse rather to presume upon your attention, than not endeavour to express myself intelligibly and warily about a subject of such moment. And this will make way for the other (subordinate) notion, that is to attend the former description: since the particular nature of an individual body consists in the general nature, applied to a distinct portion of the universe; or rather supposing it to be placed, as it is, in a world, framed by God, like ours, it consists in a convention of the mechanical affections (such as bigness, figure, order, situation, contexture, and local motion) of its parts, (whether sensible or insensible) convenient and sufficient to constitute in, or to intitle to, its particular species or denominations, the particular body they make up, as the concurrence of all these is considered as the principle of motion, rest, and changes in that body.

If you will have me give to these two notions more compendious expressions, now that, by what hath been said, I presume you apprehend my meaning; I shall express, what I called general nature, by cosmical mechanism, that is, a comprisal of all the mechanical affections (figure, size, motion, &c.) that belong to the matter of the great system of the universe. And, to denote the nature of this or that particular body, I shall style it, the private, the particular, or (if you please) the individual mechanism of that body; or, for brevity's sake, barely the mechanism of it, that is, the essential modification, if I may so speak, by which I mean, the comprisal of all its mechanical affections convened in the particular body, considered, as it is determinately placed, in a world so constituted as ours is.

It is like you will think it strange, that in this description I should make the present fabrick of the universe, a part, as it were, of the notion I frame of nature, though the generality of philosophers, as well as other men, speak of her as a plastic principle of all the mundane bodies, as if they were her effects; and therefore they usually call them the works of nature; and the changes, that are observed in them, the phenomena of nature: but, for my part, I confess, I see no need to acknowledge any architectonic being, besides God, antecedent to the first formation of the world.

THE Peripatetics, whose school either devised, or mainly propagated the received notion of nature, conceiving (not only matter, but) the world to be eternal, might look upon it, as the province, but could not, as the work of nature, which, in their hypothesis, is its guardian, without having been its architect.

THE Epicureans themselves, that would refer all things, that are done in the world, to nature, cannot, according to their principles, make what they now call nature, to have been antecedent to the first formation of our present world: for, according to their hypothesis, whilst their numberless atoms wildly roved in their infinite vacuity, they had nothing belonging to them but bigness, figure and motion; and it was by the coalition or convention of these atoms, that the world had its beginning: so that, according to them, it was not nature, but chance, that framed the world; though afterwards, this original fabrick of things does, by virtue of its structure, and the innate and unloseable motive power of atoms, continue things in the same state for the main; and this course, though casually fallen into it, and continued without design, is that, which, according to their hypothesis, ought to pass for nature.

AND, as meer reason doth not oblige me to acknowledge such a nature, as we call in question, antecedent to the origin of the world; so neither do I find, that any revelation contained in the holy scriptures, clearly teaches, that there was such a being. For, in the history of the creation, it is expressly said, that *in the beginning God made the heavens and the earth*; and, in the whole account, that *Moses* gives of the progress of it, there is not a word of the agency of nature; and, at the latter end, when God is introduced, as making a review of all the parts of the universe, it is said, that *God saw every thing that he had made*; and it is soon after added, that *he blessed and sanctified the seventh day, because, in it, (or rather, just before it, as I find the Hebrew particle elsewhere used) he had rested from all his works, which God created and made*. And though there be a passage in the book of *Job*, that, probably enough, argues the angels (there called the sons of God) to have existed, either at the beginning of the first day's work, or some time before it; yet it is not there so much as intimated, that they were co-operators with their Maker, in the framing of the world, of which they are represented as spectators and applauders, but not so much as instruments. But since revelation, as much as I always reverence

Gen. i. 31.

Gen. ii. 3.

Job xxxvii.

4, 6, 7.

rence it, is, I confess, a foreign principle in this philosophical inquiry, I shall wave it here, and tell you, that, when I consult only the light of reason, I am inclined to apprehend the first formation of the world, after some such manner as this:

I THINK it probable, (for I would not dogmatize on so weighty, and so difficult a subject) that the great and wise Author of things did, when he first formed the universal and undistinguished matter into the world, put its parts into various motions, whereby they were necessarily divided into numberless portions of differing bulks, figures, and situations, in respect of each other; and that, by his infinite wisdom and power, he did so guide and over-rule the motions of these parts, at the beginning of things, as that (whether in a shorter or a longer time, reason cannot well determine) they were finally disposed into that beautiful and orderly frame, we call the world; among whose parts some were so curiously contrived, as to be fit to become the seeds, or seminal principles of plants and animals. And I further conceive, that he settled such laws or rules of local motion, among the parts of the universal matter, that, by his ordinary and preserving concurrence, the several parts of the universe, thus once completed, should be able to maintain the great construction, or system and œconomy of the mundane bodies, and propagate the species of living creatures. So that, according to this hypothesis, I suppose no other efficient of the universe, but God himself, whose almighty power, still accompanied with his infinite wisdom, did at first frame the corporeal world, according to the divine ideas, which he had, as well most freely, as most wisely determined to conform them to: for, I think, it is a mistake to imagine, (as we are wont to do) that what is called the nature of this or that body, is wholly comprised in its own matter, and its (I say not substantial, but) essential form; as if from that, or these only, all its operations must flow. For an individual body being but a part of the world, and encompassed with other parts of the same great automaton, needs the assistance or concurrence of other bodies, (which are external agents) to perform divers of its operations, and exhibit several phænomena that belong to it. This would quickly and manifestly appear, if, for instance, an animal or an herb could be removed into those imaginary spaces the schoolmen tell us of, beyond the world; or into such a space, as the Epicureans fancy their *intermundia*, or empty intervals, between those numerous worlds, their master dreamed of: for, whatever the structures of these living engines be, they would as little, without the co-operations of external agents, such as the sun, æther, air, &c. be able to exercise their functions, as the great mills commonly used with us, would be to grind corn, without the assistance of wind or running water. Which may be thought the more credible, if it be considered, that by the mere exclusion of the air, (though not of light, or the earth's magnetical effluvia, &c.) procured by the air-pump, bodies placed in an extraordinary large glass, will presently come into so differing a state, that warm animals cannot live in it; nor flame (though of pure spirit of wine) burn; nor syringes draw up water, nor bees, or such winged insects fly; nor caterpillars crawl; nay, nor fire run along a train of dried gun-powder: all which I speak upon my own experience. According to the foregoing hypothesis, I consider the frame of the world already made, as a great, and, if I may so speak, pregnant automaton, that, like a woman with twins in her womb, or a ship furnished with pumps, ordnance, &c. is such an engine, as comprises or consists of several lesser engines; and this compounded machine, in conjunction with the laws of motion, freely established and still maintained by God, among its parts, I look upon as a complex principle, whence results the settled order or course of things corporeal. And that which happens, according to this course, may, generally speaking, be said to come to pass according to nature, or to be done

by nature; and that, which thwarts this order, may be said to be preternatural, or contrary to nature. And indeed, though men talk of nature as they please, yet whatever is done among things inanimate, which make incomparably the greatest part of the universe, is really done but by particular bodies, acting on one another by local motion, modified by the other mechanical affections of the agent, of the patient, and of those other bodies, that necessarily concur to the effect, or the phenomenon produced.

[N. B.] THOSE, that do not relish the knowledge of the opinions and rites of the ancient *Jews* and *Heathens*, may pass on to the next or fifth section, and skip the whole following excursion, comprised between double paratheses, which, though neither impertinent nor useless to the scope of this treatise, is not absolutely necessary to it.

[In the foregoing (third) section of this treatise, I hope I have given a sufficient reason of my backwardness to make frequent use of the word nature; and now, in this (fourth) section, having laid down such a description of nature, as shews that her votaries represent her as a goddess, or at least a semi-deity; it will not be improper, in this place, to declare some of the reasons of my dissatisfaction with the notion or thing itself, as well as with the use of the name; and to shew, why I am not willing to comply with those many, that would impose it upon us as very friendly to religion.

AND these reasons I shall the rather propose, because not only the generality of other learned men, (as I just now intimated) but that of divines themselves, for want of information, or for some other cause, seem not to have well considered so weighty a matter.

To manifest therefore the malevolent aspect, that the vulgar notion of nature has had, and therefore possibly may have, on religion; I think fit, in a general way to premise, what things they are, which seem to me to have been the fundamental errors, that misled the Heathen world, as well philosophers as others: for, if I mistake not, the looking upon merely corporeal, and oftentimes inanimate things, as if they were endowed with life, sense, and understanding; and the ascribing to nature, and some other beings, (whether real or imaginary) things, that belong but to God, have been some, (if not the chief) of the grand causes of the polytheism and idolatry of the gentiles.

The most ancient idolatry, (taking the word in its laxer sense) or at least one of the earliest, seems to have been the worship of the celestial lights, especially the sun and moon; that kind of *Aboda zara*, עבודה זרה (as the Jewish writers call strange or false worships) being the most natural, as having for its objects, glorious bodies, immortal, always regularly moved, and very beneficial to men. There is recorded, in the holy scripture, a passage of *Job*, who is probably reputed to be, at least, as antient as *Moses*, which seems to argue, that this worship, of the two great luminaries, was practised in his time, and looked upon as criminal by religious men; and, as our English version renders the Hebrew words, punishable by the civil magistrate.

Job xxxi.
26, 27.

If, says *Job*, I beheld the sun, when it shined, or the moon walking in brightness: and my heart hath been secretly inticed, or my mouth hath kissed my hand, &c. And that this idolatry was practised in *Moses's* time, may be gathered from that passage in Deuteronomy. And lest thou lift up thine eyes unto heaven, and when thou seest the sun, and the moon, and the stars, even all the host of heaven, shouldst be driven to worship them, and serve them, &c. The Sabeans, or, as many critics call them, the Zabians, are, by

Deut. iv.
19.

More. N.
wach. lib.

3. c. 30.

some very learned men, thought to have been the earliest idolaters: and the ablest of the Jewish Rabbies, *Maimonides*, makes them to be so antient, that *Abraham* was

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put to dispute against them. And their superstition had so overspread the East, in *Moses's* time, that the same *Maimonides* judiciously observes, that divers of the ceremonial laws, given to the *Jews*, were instituted in opposition to the idolatrous opinions, magical rites, and other superstitions of the *Zabians*. Of this he (seconded therein by our famous *Selden*) gives several instances; to which, some are added by the learned *Hottinger*. But this only upon the by; my purpose in mentioning these *Zabians*, being to observe to you, that they looked upon the planets, and especially the sun and moon, as gods, and worshipped them accordingly, taking them for intelligent beings, that had a great interest in the government of the world. *Hist. Orientalis lib. 1. cap. 3.*

This may be proved out of some Eastern writers, especially *Maimonides*, who, in one place, asserts the *Zabians* to have adored the sun and moon, and the host of heaven, (as the scripture styles the celestial lights) as true gods: and this we shall the less wonder at, if we consult another place of the same learned author, wherein he informs the readers, that these idolaters (the *Zabians* or *Chaldeans*) made statues of silver and gold, those for the sun, and these for the moon; which, being consecrated by certain rites and ceremonies, did invite, and, as it were, attract the spirits of these stars into those shrines; whence they would speak to their worshippers, acquaint them with things profitable, and even predict to them things to come. And of some such sort of speaking images, some learned criticks suppose the *Teraphim* (as the original text calls them) to have been, that *Laban* so prized, as to call them his gods: which it is guessed *Rachel* stole from her father, lest, by consulting them, he might learn what way her husband and his company had taken in their flight. And the same great Rabbi having informed his readers, that he saw several books of the *Zabian* superstition, somewhere mentions one or two that treated of speaking-images. And it was perhaps from these *Zabians*, or their disciples, that *Zeno*, the founder of the Stoical sect, taught, as *Stobæus* informs us, that the sun, moon, and the rest of the stars were endowed with understanding and prudence. And *Seneca*, an eminent champion of that rigid sect*, reprehends *Epicurus* and *Anaxagoras*, (whose disciple he was, in that opinion) that they held the sun to be a burning stone, or an aggregate of casual fires, and any thing, rather than a god. *Lib. 3. cap. 36. 2 Kings xvii. 16. 2 Chron. xxxiii. 3. Mor. Ne-voeb. lib. 3. cap. 25. Gen. xxxi. 19. 30. * Sen. de Benef. lib. 7. c. 23.*

I AM sorry I could not avoid thinking the great *Hippocrates* to have been involved in the great error we are speaking of, when in his book *De principiis aut carnibus*, near the beginning, I met with this passage; *Videtur sane mihi id, quod (Θεῖον) calidum vocamus, immortale esse, et cuncta intelligere et videre, et audire et scire omnia, tum præsentia tum futura*. According to which supposition, he presently attempts to give some such account of the origin of the world's frame, as he could in a very few lines; and then spends the rest of the book in giving particular accounts, how the parts of the human body come to be framed; wherein, though I commend the attempt in general, because, without acquiescing in I know not what faculties, he endeavours to give an intelligible and particular account, how things come to be performed and produced; yet I cannot but look on this book, as a remarkable instance of this truth, that, without having recourse to the true God, a satisfactory account cannot be given of the original or primitive production of the greater and lesser world, since so great a naturalist as *Hippocrates*, by the help of his idolized Θεῖον, was unable to perform this task, with any satisfaction to an attentive and intelligent inquirer. And *Galen* himself, who was not unacquainted with *Moses's* writings, and lived when Christianity was propagated through a great part of the world; *Galen*, I say, even in that admirable treatise, *De usu Partium*, where he so excellently declares and celebrates the most wise author of things, was so far transported with the error, which infected so many other heathen philosophers, that he fancied the earth itself, though

he

Galenus
de usu
Partium,
l. xvii.
apud La-
cunam in
Epitome
Oper. Ga-
leni.

he speaks contemptibly of it, had a certain soul or mind, imparted to it by the superior bodies, which, he saith, is so conspicuous, first in the sun, then in the moon, and afterwards in the other stars; that by their beauty the contemplator will be induced to think it reasonable, that the more pure their corporeal substance is, it is inhabited by a mind, so much the better and more perfect than that of these terrestrial bodies. And having spoken of the reasoning nature, that shined in *Plato*, *Aristotle*, *Hipparchus*, *Archimedes*, &c. he thus infers; *Si igitur in tanta colluvie (quo enim alio nomine quis appellet id, quod ex carne, sanguine, pituita, ac bile utraque est conflatum) mens gignatur, adeo eximia & excellens; quantam ejusdem putandum est esse excellentiam in Sole, Luna, aliisque etiam Sideribus?* (to which he subjoins) *Mihi quidem, dum hæc mecum voluto, non exigua quædam mens talis, per ipsum etiam nos aerem ambientem, esse extensa videtur. Fieri enim non potest, quum lucis ipsius Solis sit particeps, quin vim etiam ab ipso assumat.*

BUT this upon the by. Nor did this opinion of the divinity of the cœlestial bodies die with the *Zabians*, or the *Greek* philosophers. For I found, by some questions I proposed to an inquisitive person, who, having lived many years in *China* and several of the neighbouring kingdoms, had acquired skill enough in the tongues to converse with the natives; I found, I say, that in a solemn conference he had with some of the more eminent and philosophical doctors of the *Chineses* religion, they frankly profess, that they believe the heavenly bodies to be truly divine, and to be worshipped, and that upon this particular ground, that they imparted to men such good things, as light, heat, rain, &c. and the productions and consequences of these: and this belief they declared, they thought more rational, than that of the *Europeans*, who worship a deity, whose neither shape, nor colour, nor motion, nor efficacy on sublunary things, were at all visible. It agrees very well with the opinion of the antient *Greeks*, who, as *Origen* relates, called the sun, moon, and the stars *ἐμφανῆς θεοὶ καὶ ἀδιντῆς*, *conspicuous and sensible gods*. And we are taught by *Eusebius*, that the antient *Ægyptian* theologizers, whose religion was near of kin to that of the *Chaldeans*, if not borrowed of it, looked upon the sun and moon, whom they worshipped under the names of *Osiris* and *Isis*, not only as the chief gods, but as the makers and governors of much, if not of all, of the rest of the universe.

I WILL not here inquire, whether these old heathen philosophers did, besides the stars and other beings, that they adored as gods, believe one only numen or supreme deity. But that may suffice for my present purpose, which seems manifest, *viz.* that they ascribed to sensible beings, attributes peculiar to the true God; that this was occasioned by their thinking them intelligent and governing; and that these inferior beings were, by far, the most usual and familiar objects both of their discourses and their worship; and that they did (to use the phrase of the apostle of the *Gentiles*) worship the creature besides, or more than, (for the *Greek* word *κατα* may signify either) the *Creator**, who by *Moses*, the prophets, and the apostles, expressly declares a dislike of this worship, and even in that more specious and seemingly excusable kind of it, which was in use among the ten tribes that professed, and perhaps believed, their worship to be directed to the one supreme God, and him the true God of *Israel*. But this also upon the by.

THIS belief, that the world, and divers of its principal parts, as the sun, moon, stars, &c. were animated and endowed with intelligent minds, was so contagious, that not only it helped to seduce the emperor *Julian* from Christianity to heathenism, (insomuch that he gives the sun solemn thanks for his advancement to the *Roman* monarchy;) but it infected very learned men among the *Jews* and *Christians*. Of the former, I shall need to name but two; the first being the famousst and judiciousst

of

Origen.
cont. Cel-
sum. l. v.
Præparat.
l. iii. c. 4.
Damasceus
vita *Isidori*
apud *Pho-*
tium: Co-
lunt præ-
ceteris.
Diis
Ægyptii
Osirim &
Isin (i. e.
Solem &
Lunam.)
illum om-
nia con-
dere, &
figuris nu-
merisque
materiam
adornare
arbitrari.
* Rom. i.
25.
Sed nec
illam,
quam ejus-
dem Nu-
minis (So-
lis) bene-
ficio adop-
tus sum.

of the antienter *Rabbins*, *Maimonides*, in whom, I confess, I wondered to find this assertion, that the sun and stars were animated beings, endowed with understanding and will: and the other being reputed the chief and the most learned of the moderns, *Menasseh Ben Israel*, with whom I have conversed at *Amsterdam*) who in his problems *De Creatione*, hath this notable passage.—*Quod de intelligentiis tradunt, id vero mera fabula est; nam Cæli, secundum Rabbi Mosem, & rei veritatem, habent animas proprias rationali vita prædita, sicut alibi à me demonstrabitur.* And a greater man than *Maimonides*, *Origen* himself, among the Christians, not only in one place adventures to say, *Siquidem etiam Cælestes Stellæ Animalia sunt Rationalia, virtute prædita, illustrata Cognitionis Lumine, à Sapientia illa, quæ est Splendor æterni Luminis**; but in another proceeds so far, that I found (not without surprize) that he says, *the Christians sing hymns to God the Lord of all, and God the word; no otherwise than do the sun, moon, and stars, and the whole heavenly host, since all these, being a heavenly choir, do with just men celebrate the supreme God, and his only begotten [Son.]†* The boldness of these unjustified paradoxes I the less wonder at, when I consider, what has for many ages been taught by the school philosophers, from *Aristotle*; namely, that the cœlestial spheres had their peculiar intelligences, that is, rational, immortal, powerful and active Beings. It is true, that in the *Jews* and *Christians* I have been speaking of, the malignity of the error they embraced was corrected and mastered by the sound and orthodox principles they held together with it. But still it is dangerous for those, that would be loyal to him, that styles himself a *jealous God*‡, to adopt premises, that have been able to mislead such great persons, and from which many famous philosophers have plausibly enough drawn consequences very repugnant to true religion. Nor are Christians themselves so much out of danger of being seduced by these heathenish notions about an intelligent world, but that (not again to mention the apostate emperor) even in these times there is lately sprung up a sect of men, as well professing Christianity, as pretending to philosophy, who (if I be not mis-informed of their doctrine) do very much symbolize with the antient Heathens, and talk much indeed of God, but mean such a one, as is not really distinct from the animated and intelligent universe; but is, on that account, very differing from the true God, that we Christians believe and worship. And though I find the leaders of this sect to be looked upon, by some more witty than knowing men, as the discoverers of unheard of mysteries in physics and natural theology; yet their hypothesis does not at all appear to me to be new, especially when I remember, besides the passages of the antients, cited in this paper, some others of the same import, such as is particularly that of *Lucan*.

*Estque Dei sedes, nisi Terra, & Pontus, & Aer,
Et Cælum, & Virtus? Superos quid querimus ultra?
Jupiter est quodcunque vides, quocunque moveris.*

THE great affinity between the *soul of the world*, so much talked of among the heathen philosophers, and the thing, that men call nature, makes it fit for me to take notice, in this place, of the influence, which the belief of that imaginary soul had upon the *Gentiles*, with reference to religion:

THAT divers of the antient philosophers held the world to be animated; hath been observed by more than one learned man: but that, which makes more for my present purpose, is, that the same old sages did also (at least for the most part) believe, that this mundane soul was not barely a living, but a most intelligent and wisely active Being. This may be easily enough discerned by him, that shall heedfully peruse *Diogenes Laërtius's* lives of the philosophers, and particularly of *Zeno*. But at present I shall rather make use of an author, who, though he be very seldom cited for philosophical

sortem
conditio-
nemque
parvi fa-
cio; quod
ex eo ge-
nere, pe-
nes quod
Terrarum
Domina-
tus atque
Imperium
est, tempo-
ribus nos-
tris ortum
acceperim.
Julian. ad.
Regem
Solem.
More Ne-
vochim.
l. iii. c. 29.
(ni fallor.)
Pag. M.
98:
* *Origen.*
cont. Cel-
sum. l. v.
† *Origen.*
cont. Cel-
sum. l. viii.
‡ *Exod. xxx.*

Sextus
Empir.
adversus
Mathe-
mat. l.
viii.

philosophical history, seems to me to have been very well versed in it. The writer, I mean, is the acute sceptic *Sextus Empiricus*, (who is thought to have lived about *Plutarch's* time, and, by some, to have been his nephew;) who recites a long rationation of *Xenophon*, which, whether it be solid or not, is at least ingenious and plausible, but too prolix to be transcribed in this place, where we may suffice to say, that he thus concludes: *Est ergo Mundus mente præditus & Intelligens, &c.* which assertion *Sextus* himself thus proposes for him; *Si non esset aliqua Mens in Mundo, neque ulla Mens in te esset. Est autem in te Mens aliqua; ergo est etiam in Mundo. Et Ideo Mundus est Mente et Intelligentia præditus.* The same sceptic introduces *Zeno Cittieus* discoursing thus: *quod immittit semen ejus quod est particeps rationis, est ipsum quoque rationis particeps. Mundus autem emittit Semen ejus, quod est particeps rationis; est ergo Mundus rationis particeps.* To which testimonies I might add many others out of the same author, who, in the same discourse, tells us, that the Stoics held the world to be an animal. But the opinion, that the old philosophers we have been speaking of, held of the world's being endowed with an understanding or rational soul, will be yet more evident by what I now proceed to alledge, to manifest, how this opinion of theirs led them to the worship of another, than the true God.

P. M. 326.

Sextus Empiricus, in the lately cited discourse of *Xenophon*, infers from the world's being an intelligent being, that it is also a divine one; for to the lately recited conclusion, *Est ergo Mundus mente præditus et intelligens*, he immediately subjoins this other, *Et ideo Deus.* And a little after, repeating their discourse, that defended this argumentation of *Xenophon* against an objection, he concludes their reasoning thus; *Ideo Mundus est Mente & Intelligentia præditus: Cum sit autem Mente & Intelligentia præditus, est etiam Deus. Quemadmodum* (says also *Phurnutus* the philosopher,) *nos anima gubernamur, sic & Mundus animam habet, quæ vindicet illum ab interitu; & hæc vocatur Jupiter.* To which agrees that in *Cicero's Academic Questions*; *Mundum esse sapientem, & habere mentem, quæ seipsam fabricata sit, & omnia moderatur, regat.* And the reasoning of the Stoics in *St. Augustine* is very clear to the same purpose; * *Dicunt* (saith he, speaking of the embracers of that sect) *omnia Sidera partes Jovis esse, & omnia vivere atque rationales animas habere, & ideo sine controversia Deos esse.* And *Socrates* is introduced by *Aristophanes*, as no less than invoking the air and the æther together, in these words:

* August.
de Civit.
Dei. l. vii.
c. 2.

O Rex, O Imperator, Aer vaste, quæ Terram continens suspensam,
Nec non splendide Æther.

WHICH brings into my mind that plain confession of the poet *Manilius*:

Qua pateat, Mundum divino Numine verti,
Atque ipsum esse Deum.

† Natur.
Hist. l. ii.
c. 1.

To all these I shall add that notable and express passage of the elder *Pliny*; † *Mundum, & hoc quod alio nomine Cælum appellare libuit, cujus circumflexu teguntur omnia, Numen esse credi par est, æternum, immensum, neque genitum, neque interitum unquam. Sacer est, æternus, immensus, totus in toto, vero ipse totum, finitus & infinito similis, extra, intra, cuncta complexus in se, idemque Naturæ opus, & rerum ipsa Natura.*

If it be objected, that the passages I have cited out of heathen philosophers, concern the soul of the world, and not nature; I answer, that the affinity of these two is so great, that divers of the old sages seem to have confounded them, and not to have made account of any other universal nature, than the soul of the world. And however,

however, the great and pernicious errors they were led into by the belief that the universe itself, and many of its nobler parts, besides men, were endowed, not only with life, but understanding and providence, may suffice to make us Christians very jealous of admitting such a being, as that, which men venerate under the name of nature; since they ascribe to it as many wonderful powers and prerogatives, as the Idolaters did to their adored mundane soul. But I shall give a further answer to the above proposed objection, if I can shew, how sacrilegiously they abused the being we are speaking of, as well under the very name of nature, as under that of the soul of the world. On this occasion I remember a passage in * Seneca, that I did not expect to meet with, * Natur. Quæst. l. ii. c. 45. where, speaking of some ethnic opinions about thunder, *Non Jovem, (says he) qualem in Capitolio colimus, fulmina mittere, sed custodem rectoremque Universi, animam ac Spiritum Mundani hujus Operis Dominum & Artificem, cui nomen omne convenit*: to which, within a few lines after, he adds, *Vis illam Naturam vocare? Non peccabis, est enim, ex quo nata sunt omnia, cujus Spiritu vivimus. Vis illam vocare Mundum? Non falleris, ipse enim est totum quid, totus suis partibus inditus & se sustinens vi sua.* And the same author elsewhere, *Nihil (says he) Natura sine Deo est, nec Deus sine Natura, sed idem est Uterque.* And in another of the Roman fages we have this passage; *Natura est igitur, quæ continet Mundum omnem, eumque tuetur, & quidem non sine sensu ac ratione.* And the opinion, not of a private philosopher, but of the sect of Stoicks, is thus delivered by Lactantius: *Isti uno naturæ nomine res diversissimas comprehenderunt, Deum Lib. vii. Cap. 1. & Mundum, Artificem & Opus, dicuntque alterum sine altero nihil posse, tanquam Natura sit Deus Mundo permixtus. Nam interdum sic confundunt, ut sit Deus ipsa mens Mundi, & Mundus sit Corpus Dei; quasi vero simul esse ceperint Mundus & Deus.* And to let you see, that in this our free inquiry I do not, without cause, here and there style nature sometimes a semi-deity, and sometimes a goddess, and talk of some men's idolizing her; I shall here annex part of a hymn of Orpheus's, addressed immediately to nature.

ὦ Φοῖ παμμήτειρα Θεά, &c.

which his interpreter thus renders into Latin;

O Natura omnium Mater Dea, artificiosa admodum Dea,
Suscitatrix honorabilis, multa creans, Divina Regina,
Omnidomans, indomita gubernatrix, ubique splendens.

And after a few lines :

Ætheria, Terestris, & Marina Regina, &c.

I know Aristotle, and his commentators, do not so directly idolize nature, as did Orpheus (or whoever was the antient author of the hymns, that bear his name); but yet I doubt they pass further than they can justify, when they so freely and often assert, that *Natura est sapientissima*, that *Opus Naturæ est opus Intelligentiæ*, that *Natura sine suo nunquam excidit*, that *Natura semper quod optimum est facit*, (to which may be added other-like axioms;) and when they most commonly call the works of God the works of nature, and mention him and her together, not as a creator and a creature, but as two co-ordinate governors, like the two Roman consuls; as when they say frequently, and without scruple, (what I find to have been first by Aristotle himself) that *Deus & Natura nihil faciunt frustra*; to which phrase may agree that expression of Ovid, where, speaking of the chaos, whilst the bodies, that composed it, lay shuffled together, and were not yet packed, he says,

Hanc Deus & melior litem Natura diremit.

To the recital of the irreligious errors of the antient heathens, about the divinity of the world, and some of its principal parts, as the sun, moon, stars, æther, &c. I should add a redargution of them, if I thought it necessary, in this place, solemnly to refute opinions, some of which are altogether precarious, and others very improbable. Those Greek and Latin philosophers, that held the sun to be a fire, were much at a loss to find out fuel to maintain the flame. But those *Zabians* and *Chaldeans*, that thought him endowed, not only with a living soul, but with understanding and will, must, if they had duly considered things, have been much more puzzled, to find not only food for so vast a body, (above 160 times bigger than the terraqueous globe) but to find in him the organs necessary to the preparations and digestion of that food, and to the other functions, that belong to animal nutrition. And if we admit the Cartesian hypothesis, the way, whereby the sun, fixed stars, and planets, are generated, will sufficiently manifest them to be neither intelligent nor living bodies: and perhaps I could here propose a quite other hypothesis, about the nature of the sun, and the fuel of its fire, that may be countenanced by some phænomena and experiments, without making him other than an igneous, and altogether inanimate body, whose flame needs to be repaired by fuel furnished to it nearer hand, than from the sea or earth. But I purposely omit such objections against the opinion I oppose, as though drawn from the dictates of sound philosophy about the origin of things, may be questioned, without being to be cleared in few words. It is also without proof, that it is presumed and asserted, that the cœlestial bodies, newly mentioned, are endowed with understanding and prudence, especially so, as to be able to know the particular conditions and transactions of men, and hear and grant the prayers of their worshippers. And the moon, which was one of their principal deities, and by them preferred before all the other planets and stars, the sun excepted, is so rude and mountainous a body, that it is a wonder, that speculative men, who considered, how many, how various, and how noble functions belong to a sensitive soul, could think a lump or mass of matter, so very remote from being fitly organized, should be animated and governed by a true living and sensitive soul. I know, that both these deifiers of the cœlestial globes, and also the heathen disciples of *Aristotle*, besides divers of the same mind even among the Christians, say great and lofty things of the quintessential nature of the heavenly bodies, and their consequent incorruptibility; of the regularity of their motions, and of their divine quality of light, that makes them resplendent: but the persuasion they had of this quintessential nature of the superior part of the world, was not, if I guess aright, grounded upon any solid physical reason, but was entertained by them for its congruity to the opinion they had of the divinity

L. xi. c. 3. of the cœlestial bodies; of which *Aristotle* himself, especially in his books *de Cælo*, speaks in such a way, as hath not a little contributed, among his followers, to such an excessive veneration for those bodies, as is neither agreeable to true philosophy, nor friendly to true religion. He himself takes notice, that the *Pythagoreans* held our earth to be one of the planets, and that it moved about the sun, which they placed in the middle of the world. And since this hypothesis of the earth's motion was in the last age revived by *Copernicus*, not only those great men *Keplerus*, *Galileo*, and *Gassendus*, but most of the best modern astronomers, and besides *des Cartes* and his sect, many other naturalists have embraced this hypothesis; which, indeed, is far more agreeable to the phænomena, not only than the doctrine of *Aristotle*, (who was plainly mistaken about the order and consistence of the heavens) but than the antient and generally received Ptolomaic system. Now, supposing the terraqueous globe to be a planet, he, that considers, that it is but a round mass of very heterogeneous substances, (as appears by the differing natures of its great constituent parts, land and sea)

Aristot. de
Cælo. l.
xi. c. 13.

sea) whose surface is very rude and uneven, and its body opacous, unless as it happens to be enlightened by the sun, moon, and stars, and so very inorganic for so much as nutrition, that it seems wholly unfit to be a living animal: I say, he, that considers such things, will scarce be forward to ascribe understanding and providence, much less a divine nature, to the other stars; as for instance, to the moon, which our best telescopes manifest to be a very craggy and mountainous body, consisting of parts of very differing textures, (as appears by her brighter parts and permanent spots) and which of herself is opacous, having no manifest light, but what she borrows from the sun, and perhaps from the earth,

As for the boasted immutability of the heavenly bodies, besides that it may be very probably called in question by the phænomena of some (for I do not say every one) of the comets, that by their parallax were found to be above the moon, and consequently in the cœlestial region of the world: besides this, I say, the incorruptibleness and immutability of the heavenly bodies is more than probably disproveable by the sudden and irregular generation, changes, and destruction, of the spots of the sun; which are sometimes so suddenly destroyed, that I remember in the year 1660, on the 8th of May, having left in the morning a spot, whose motions we had long observed through an excellent telescope, with an expectation, that it would last many days visible to us, we were surprized to find, that, when we came to observe it again in the evening, it was quite dissipated, though it seemed thick; and by comparing it to the sun, we estimated the extent of its surface to be equal to that of all *Europe*. As to the constancy of the motions of the stars; if the earth, which we know to be inanimated, be a planet, it moves as constantly and regularly about the sun, (in that which they call the great orb,) as the other planets do, or as the moon doth about the earth. And I consider, that though we should suppose our globe not to be a planet, yet there would manifestly be a constant motion, and regular enough, of a great part of it; since (bating some anomalies, that shores, winds, and some other extrinsic things, occasion,) there is a regular ebbing and flowing twice a day, and also spring-tides twice a month, of that vast aggregate of waters, the ocean; which perhaps is not inferior in bulk to the whole body of the moon, and whereof also vast tracts are sometimes observed to shine.

AND lastly, whereas a great proof of the divinity of the stars is taken from their light; though I grant it to be the noblest of sensible qualities, yet I cannot think it a good proof of the divine, or very excellent, nature of bodies endowed with it, whether they be cœlestial or not. For whereas the *Zabians* and *Chaldeans* considered and adored the planets, as the chief gods, our telescopes discover to us, that, except the sun, (if he be one, rather than a fixed star) they shine but by a borrowed light; insomuch that *Venus*, as vividly luminous as it appears to the naked eye, is sometimes seen (as I have beheld it) horned like the moon in no long time after her change. And at this rate also the earth, whether it be a planet or no, is a luminous body, being enlightened by the sun; and possibly, as a body forty times bigger, communicates more light to the moon, than it receives from her, as is probably argued from the light seen on the surface of the moon in some of her eclipses. And, though in the night, when the darkness hath widened the pupils of our eyes, and the moon shines with an unrivaled lustre, she seems exceeding bright, yet she may be, for aught I know, more opacous than the solid part of the terrestrial globe: for I remember, that I have more than once heedfully observed a small cloud in the west, where the moon then was, about sun set; and comparing them together, the little cloud, as opacous and loose a body as it was, reflected the light as strongly to my eye, as did the moon, that seemed perhaps to be not far from it, both of them appearing like little

whitish clouds, though afterwards, as the sun descended lower and lower beneath the horizon, the moon grew more and more luminous. And, speaking of light indefinitely, it is so far from arguing a divine nature in the bodies, that are endowed with it, whether, as the planets, by participation from an external illuminant, or as the sun, from an internal principle; that a burned stone, witness that of Bolonia, will afford, in proportion to its bulk, incomparably more borrowed light, than one of the planets. And a light from its internal constitution may be found, not only in such abject creatures as insects, whether winged, as the cucupias of *Hispaniola*, or creeping, as our glow-worms; but also in bodies inanimate and corrupted, as in rotten wood, in stinking whittings, and divers other putrified fishes.

I cannot now stay to inquire, how the Zabians, and such idolaters as they, could make out the connexion, symmetry, and subordination or dependance of the several parts of the world, composed of so many different and distant beings, endowed not only with animal souls, but with their distinct and peculiar understandings and wills, and many of them also with divine nature. Nor shall I consider, how strange a monster, rather than an animal and a deity, those many heathen philosophers and their adherents must make of the universe, who held it to be but one; and yet were of the paradoxical opinion, that (as hath been elsewhere noted) is roundly professed by *Stobæus*, at the very beginning of his physical eclogues, Ζεύς ἔν, &c. i. e. *Jupiter (quidem) totus mundus est: animal ex animalibus; numex ex numinibus compositum.*

THESE, I say, and the like objections against the pagan doctrine, I must not now insist on, because I perceive, that I have slipped into a somewhat long digression, (which yet perhaps may not be altogether unseasonable or useless;) which therefore I shall here break off, to resume and conclude the discourse, that this section was allotted to, which I might easily have enlarged; but I presume there is enough said in it already, to let you see, that it is a dangerous thing to believe other creatures, than angels and men, to be intelligent and rational; especially to ascribe to any of them an architectonic, provident, and governing power. And though I readily acknowledge, that there is no great danger, that well instructed Christians should, like some Heathens, worship nature as a Goddess; yet the things I formerly alledged, to shew it unsafe to cherish opinions of kin to those, that misled a multitude even of philosophers, make me fear too many, and not a few of the learned themselves, may have a veneration for what they call nature; much greater than belongs to a meer creature; if they do not, to use a scripture expression, *worship the creature, above or besides the creator*, who, and not the world, nor the soul of it, is the true God. And though I should grant, that the received notion of nature doth neither subvert, nor much endanger any principle of religion; yet that is not enough for the purpose of those naturists I reason with; since they are here supposed to make it a fault in others, not to ascribe to the nature they venerate, as much as themselves do; and they represent their own notion of it, not only as innocent, but as very useful, if not necessary to religion.

Rom. i.
25.

S E C T. V.

IV. I COME now, *Eleutherius*, to acquaint you with some of the reasons, that have made me backward to entertain such a notion of nature, as I have hitherto discoursed of; and I shall at present comprise them under the following five.

I. THE first whereof is, that such a nature, as we are speaking of, seems to me to be either asserted, or assumed without sufficient proof. And this single reason, if it be well made out, may, I think, suffice for my turn. For, in matters of philosophy, where

where we ought not to take up any thing upon trust, or believe it without proof, it is enough to keep us from believing a thing, that we have no positive argument to induce us to assent to it, though we have no particular arguments against it. And if this rule be to take place in lesser cases, sure it ought to hold in this, where we are to entertain the belief of so catholick an agent, that all the others are looked upon but as its instruments, that act in subordination to it; and which, being said to have an immediate agency in many of the phænomena of the world, cannot but be supposed to be demonstrable by divers of them. I have yet met with no physical arguments, either demonstrative, or so much as considerably probable, to evince the existence of the nature we examine. And, though I should admit the use, that some divines contend for, of the holy scriptures in philosophical controversies; yet I should not be persuaded of the existence of the nature, we dispute of: for I do not remember, that the scripture any where declares to us, that there is such a thing, (in the sense by me questioned) though (as I formerly noted more fully in the IV. section,) in *Genesis* and some other places, where the corporeal works of God are expressly treated of, (though in order to spiritual ends) one might probably enough expect to find some mention of God's grand vicegerent in the universe of bodies, if he had established any such. But whatever be the true cause of the scripture's silence about this matter, the silence itself is sufficient to justify me for examining freely by reason a thing, that is not imposed on my belief by revelation. And as for the physical arguments, that may be brought in favour of the questioned notion of nature, I shall, ere long, examine the principal of them, and shew that they are not convincing. To these things may be added, as to the proof drawn from the general opinion about nature, that being a popular, not a physical argument, it may indeed pass for current with the vulgar, but ought not to do so with philosophers.

II. THE second reason is taken from the unneccessariness of such a nature, as is pretended: for, since a great part of the work of true philosophers has been, to reduce the true principles of things to the smallest number they can, without making them insufficient; I see not, why we should take in a principle, of which we have no need. For supposing the common matter of all bodies to have been at first divided into innumerable minute parts, by the wise author of nature, and these parts to have been so disposed of, as to form the world, constituted as it now is; and especially, supposing that the universal laws of motion, among the parts of the matter, have been established, and several conventions of particles contrived into the seminal principles of various things; all which may be effected by the mere local motion of matter, (not left to itself, but skilfully guided at the beginning of the world) if (I say) we suppose these things, together with God's ordinary and general concurrence, which we very reasonably may; I see not, why the same phænomena, that we now observe in the world, should not be produced, without taking in any such powerful and intelligent being, distinct from God, as nature is represented to be. And, till I see some instance produced to the contrary, I am like to continue of this mind, and to think, that the phænomena, we observe, will genuinely follow from the mere fabrick and constitution of the world: as, supposing the sun and moon to have been put, at first, into such motions about the earth, as experience shews they have, the determinate celerity of these motions, and the lines, wherein they are performed, will make it necessary, that the moon should be sometimes full, sometimes scarce illuminated at all to us-ward, sometimes horned, and, in a word, should exhibit such several phases, as every month she doth, and that, at sometimes, she and the sun should have a trine, or a quadrate aspect, &c. and that now one, and now the other of them, should, at set times, suffer an eclipse; though these eclipses were, by the Romans, and others of old,

and

Heb. xi.
10.

and are by many unlearned nations at this day, looked upon as supernatural beings; and though also *Aristotle*, and a multitude of his followers, fancied, that such regular motions could not be maintained without an assistant intelligence, which he and they therefore assigned to each of the heavenly orbs. And indeed the difficulty we find to conceive, how so great a fabric, as the world, can be preserved in order, and kept from running again to a chaos, seems to arise from hence; that men do not sufficiently consider the unsearchable wisdom of the divine architect, or Δημιουργος (as the scripture styles him) of the world, whose piercing eyes were able to look, at once, quite through the universe, and take into his prospect both the beginning and end of time: so that perfectly fore-knowing, what would be the consequences of all the possible conjunctures of circumstances, into which matter, divided and moved according to such laws, could, in an automaton so constituted as the present world is, happen to be put; there can nothing fall out, unless when a miracle is wrought, that shall be able to alter the course of things, or prejudice the constitution of them, any further, than he did from the beginning foresee, and think fit to allow.

NOR am I sure, that the received notion of nature, though it be not necessary, is at least very useful, to explicate physical phænomena: for besides that I shall shew ere long, that several explications, where recourse to it is presumed to be the most advantageous, are not to be allowed; to give the nature of a thing for the cause of this or that particular quality, or operation of it, is to leave men as ignorant as they were before; or, at least, is to acknowledge, that a philosopher can, in such cases, assign no better particular and immediate causes of things, than a shepherd or a tradesman, that never learned natural philosophy, can assign of the same things, and of a thousand others. And though it be true, (as I formerly also intimated) that, in many cases, philosophers themselves can answer no otherwise to such questions, as may be proposed to them, than by having recourse to the nature of the thing; yet such answerers do not declare the proper cause of a dark phænomenon, but only that he, who employs them, does not yet know it: and so this indefinite notion of nature, which is equally applicable to the resolving of all difficulties, is not useful to disclose the thing, but to delude the maker of the question, or hide the ignorance of the answerer.

III. My third argument is, that the nature, I question, is so dark and odd a thing, that it is hard to know what to make of it, it being scarce, if at all, intelligibly proposed by them, that lay most weight upon it. For it appears not clearly, whether they will have it to be a corporeal substance, or an immaterial one, or some such thing, as may seem to be betwixt both; such as many Peripatetics do represent substantial forms, and what they call real qualities, which divers school-men hold to be (at least by miracle) separable from all matter whatsoever. If it be merely corporeal, I confess I understand not, how it can be so wise, and almost omniscient an agent, as they would have it pass for: besides, that if it be a body, I would gladly know, what kind of body it is; and how, since, among bodies, there can be no penetration of dimensions, this body can so intimately pervade, as they pretend nature does all the other bodies of the world? And to this I would add divers other questions that would not be easily answered: (but I shall resume this third argument in another place.) If it be said, that nature is a semi-substantia, as some of the modernest school-men are pleased to call substantial forms and real qualities; I roundly answer, that I acknowledge no such chimerical and unintelligible beings, and shall only desire you to apply to them a good part of the discourse, made in certain papers, occasioned by a chymico-physical essay about salt-petre, against the pretended origin, and inexplicable nature of the imaginary substantial forms of the Peripatetics.

ripatetics. It remains therefore, that this nature, we speak of, if it be any thing positive, should be an immaterial substance: but to have recourse to such an one, as a physical agent, and not only a determiner, but the grand author of the motion of bodies, and that, especially, in such familiar phænomena, as the ascension of water in pumps, the suspension of it in water-pots for gardens, the running of it through siphons, and I know not how many others, and to explain its casualty, as they speak, will I think, prove a work exceeding difficult: though I shall not here spend time to shew the farther inconveniences of such a supposition, being to do that hereafter; and, in the mean-while, contenting myself to observe, as to many of the naturists, that though their doctrine may favour it, they seem rather content to talk darkly, and uncertainly, of what they call nature, than by clearly defining it, expose it to objections not easy to be answered, and who foresee the advantage, that the unsettledness of the notion gives them, to pretend knowledge, or disguise ignorance.

IV. SINCE many of the most learned amongst the naturists are Christians; and not few of them divines too, it may not be improper (which else I should, perhaps, think it would be) to add, in this place, that the next thing, for which I dislike the vulgar notion (or idea) of nature, is, that I think it dangerous to religion in general, and consequently to the Christian.

FOR this erroneous conceit defrauds the true God of divers acts of veneration and gratitude, that are due to him from men, upon the account of the visible world, and diverts them to that imaginary being they call nature, which has no title to them; for whilst nature is supposed to be an intelligent thing, that wisely and benignly administers all, that is done among bodies, it is no wonder that the generality of philosophers, and, after their example, of other men, should admire and praise her, for the wonderful, and for the useful things, that they observe in the world. And, in effect, though nature, in that sense of the word I am speaking of, be never (that I remember) to be found in the sacred writings; yet nothing is to be more frequently met with (and that adorned with titles and encomiums) in the books of philosophers, than nature and her effects. And, if we consider, that whatever has been said by some, in excuse of *Aristotle* himself, yet the generality of the Peripatetics, from whom the vulgar notion of nature is chiefly received, made the world to be eternal, and referred all the transactions among the bodies it contains, to what they called nature. Whence it will not be difficult to perceive, that, if they do not quite exclude God, yet, as they leave him no interest in the first formation of the universe, so they leave him but very little in the administration of the parts it consists of, especially the sublunary ones: so that, instead of the true God, they have substituted for us a kind of a goddess, with the title of nature; which as they look upon as the immediate agent and director, in all excellent productions, so they ascribe to her the praise and glory of them.

WHETHER this great error, in a point of such importance, may not undermine the foundation of religion, I think it may not irrationally be suspected: for, since the most general and efficacious argument, that has persuaded philosophers, and other men, that there is a God and a consideration of the providence, is afforded by the visible world, wherein so many operations and other things are observed, that are managed (or performed) with such conduct and benignity, as cannot justly be ascribed but to the wisdom and goodness of a Deity; they, that ascribe these things to mere nature, do much weaken the force of that argument, if they do not quite take away the necessity of acknowledging a Deity, by shewing, that without any need of having recourse to him, of the administration of the world, and of what is performed.

performed among things corporeal, an account may be given. Though when men are put upon considering the matter, and pressed to declare themselves more clearly, they are ashamed to affirm, that God and nature are the same thing, and will confess, that she is but his vicegerent; yet, in practice, their admiration and their praises are frequently given to nature, not to God: in like manner, as, though the sun be the fountain of light, and the moon derives all hers from the sun; yet the sea, in its grand motions of ebbing and flowing, appears to respect the moon, and not the sun: for thus the generality of men, though they will acknowledge, that nature is inferior and subordinate to God, do yet appear to regard her more than him.

To be short, nature uses to be so frequently recurred to, and is so magnified in the writings of physiologists, that the excessive veneration men have for nature, as it has made some philosophers (as the Epicureans) deny God, so it is to be feared, that it makes many forget him: and, perhaps, a suspicious person would venture to add, that, if other principles hindered not (as, I know, that in many, and, I think, that in most of the Christian naturists they do) the erroneous idea of nature would, too often, be found to have a strong tendency to shake, if not to subvert, the very foundations of all religion; misleading those, that are inclined to be its enemies, from over-looking the necessity of a God, to the questioning, if not to the denial of his existence.

V. My fifth and last argument is taken from hence; that I observe divers phenomena, which do not agree with the notion or representation of nature, that I question: for if indeed there were such an intelligent, powerful, and vigilant being, as philosophers are wont to describe nature to be, divers things would not be done, which experience assures us are done.

AND here I shall, once for all, give an advertisement, which I desire may be called to mind, whenever there shall be occasion, in the following part of this tract, which is this: that because inanimate bodies are usually more simple, or less compounded, and of a slighter and less complicated or curious contrivance, than animals or plants, I thought fit to chuse most of the instances I employ, rather among lifeless bodies, whose structure and qualities are more easy to be intelligibly and with brevity discoursed of, than among living creatures, whose textures, being organical, are much more intricate and subtle. And this course I did not scruple to take, because the celebrators of nature give her a province, or rather an empire, as large as the world, and will have her care and jurisdiction reach, as well to inanimate, as to living bodies; and accordingly most of the conspicuous instances they alledge of her providence and power, are taken from bodies destitute of life; as when they tell us that the ascension of water in sucking pumps, and the sustentation of it in gardeners watering pots, are caused by nature's abhorrence of a vacuum: that heavy bodies (unhindered) fall to the ground in a perpendicular line, because nature directs them the shortest way to the centre of the earth; and that bubbles rise through the water, and flames ascend in the air, because nature directs the bodies to rejoin themselves to their respective elements; to omit other instances of this sort, that there will be occasion to mention hereafter: till when, these may suffice to warrant my taking most of my instances from inanimate bodies; though I shall not confine myself to these, especially when I shall come to answer objections, that are taken from living creatures.

THE foregoing advertisement will be, I hope, found conducive to clear the way for my fifth argument, lately proposed, which concludes, that if indeed there were such a being, as nature is usually represented to be, several things would be otherwise administered in the universe, than experience shews they are.

To enumerate all the particulars, that may be proposed to make this good, would swell this discourse much beyond the bulk, to which my haste obliges me to confine it. But, to make you amends for the paucity of instances, I shall now name, by the kind of them; I shall propose such, as, for the most part, are taken from those very things, whence the wisdom and vigilancy of nature is wont to be confidently argued, which I the rather do, that by such I may make way for, and shorten the answers I am to give to the arguments ere long to be examined.

FIRST then, whereas the great care and vigilancy of nature, for the common good of the universe, is wont to be demonstrated from the watchful care she takes to prevent or replenish a vacuum, which would be very prejudicial to the fabric of the world: I argue the quite contrary from the phænomena, that occur about a vacuum. For whereas it is alledged, that nature, in great pumps, and in the like cases, lifts up the heavy body of water in spite of its tendency towards the centre of the earth, to obviate, or fill up a vacuity; and that out of a gardener's pot, or inverted pipe, stopped at one end, neither the water, nor even quicksilver, that is near fourteen times as heavy, will fall down, lest it should leave a vacuum behind it; I demand, how it comes to pass, that, if a glass pipe be but a foot longer than 34 or 35 feet, or an inverted tube, filled with quicksilver, be but a finger's breadth longer than 30 inches, the water in the one, and the quicksilver in the other, will subside, though the one will leave but about a foot, and the other but about an inch, of deserted space, which they call vacuum, at the top of the glass? Is it possible, that nature, that in pumps is said to raise up every day so many hundred tun of water, and if you believe the schools, would raise it to any height, (lest there should be a vacuum) should not have the discretion, or the power, to lift up, or sustain, as much water as would serve to fill one foot in a glass tube, or as much quicksilver, as an inch of a slender pipe will contain, to obviate or replenish the vacuum, she is said so much to abhor? Sure at this rate, she must either have very little power, or very little knowledge of the power she has. So likewise, when a glass bubble is blown very thin at the flame of a lamp, and hermetically sealed, whilst it is very hot; the cause, that is rendered, why it is apt to break, when it grows cold, is, that the inward air, which was before rarefied by the heat, coming to be condensed by the cold, lest the space deserted by the air, that thus contracts itself, should be left void, nature, with violence, breaks the glass in pieces: but, by these learned men's favour, if the glass be blown but a little stronger than ordinary, though at the flame of a lamp, the bubble, as I have often tried, will continue unbroken, in spite of nature's pretended abhorrency of a vacuum; which needs not at all to be recurred to in the case: for the reason, why the thin glass broke not when it was hot, and did when it grew cold, is plainly this; that, in the former state, the agitation of the included air, by the heat, did so strengthen the spring of it, that the glass was thereby assisted and enabled to resist the weight of the incumbent air; whereas upon the cessation of that heat, the debilitated spring of the internal being unable to assist the glass, as formerly, to resist the pressure of the external air, the glass itself being too thin, becomes unable to support the weight or pressure of the incumbent air; the atmospherical pillar, that leans upon a bubble of about two inches diameter, amounting to above one hundred pound weight, as may be manifestly concluded from a late experiment, that I have tried, and you may meet with in another paper. And the reason, why, if the bubble be blown of a due thickness, it will continue whole after it is cold, is, that the thickness of it, though but faintly assisted by the weakened spring of the included air, is sufficient to support the weight of the incumbent air, though, several times, I have observed the pressure of the atmosphere, and the resistance of the bubble, to have been, by accident, so near the equipollent, that

a much less outward force than one would imagine, applied to the glass, as, perhaps, a pound, or a less weight, gently laid on it, would enable the outward air to break it, with noise, into a multitude of pieces. And, now give me leave to consider, how ill this experiment, and the above mentioned phenomena, that happen in glass pipes, wherein water and quicksilver subside, agree with the vulgar apprehension men have of nature: for, if in case she did not hinder the falling down of the water, or the quicksilver, there would be no such vacuum produced, as she is said to abhor; why does she seem so solicitous to hinder it? And why does she keep three or four and thirty feet of water in perpendicular height, contrary to the nature of all heavy bodies, suspended in the tube? And why does she furiously break in pieces a thin sealed bubble, such as I come from speaking of, to hinder a vacuum? If, in case she did not break it, no vacuum could ensue? And, on the other side, if we admit her endeavours, to hinder a vacuum, not to have been superfluous, and consequently foolish, we must confess, that, where these endeavours succeed not, there is really produced such a vacuum, as she is said to abhor: so that, as I was saying, either she must be very indiscreet to trouble herself, and to transgress her own ordinary laws, to prevent a danger she need not fear; or her strength must be very small, that is not able to fill a vacuity, that half a pint of water, or an ounce of quicksilver, may replenish; or break a tender glass bubble, which, perhaps, a pound weight on it would, with the help of so light a body as the incumbent air, crush in pieces.

THE other grand instance, that is given of the wisdom of nature, and her watchfulness for the good of the whole world, is the appetite she has implanted in all heavy bodies, to descend to the centre of the earth, and in all light ones, to ascend towards heaven; or, as some would have it, towards the element of fire, contiguous to the orb of the moon. But for positive levity, till I see it better proved, than it hath hitherto been, I allow no such thing implanted in sublunary bodies; the prepollent gravity of some sufficing to give others a comparative or respective lightness. As a piece of oak, or the like wood, being let go in the air, falls down by its own gravity, or rather by virtue of the efficient of that gravity; but if it be let go under water, it will, though it be never so great a log or piece of timber, ascend, with a considerable force, to the top of the water; which, I hope, will not be ascribed to a positive levity, since, when it is descended in the air, it was by its gravity, that it did so. But not to insist on this, nor to take notice, how wisely nature has implanted in all heavy bodies an appetite to descend to the centre of the earth, which being but a point, is not able to contain any one of them; not to urge these things, I say, I will only invite you to consider one of the most familiar things, that occur among heavy bodies.

For if, for example, you let fall a ball upon the ground, it will rebound to a good height, proportionable to that, from whence you let it fall, or, perhaps, will make several lesser rebounds, before it come to rest. If it be now asked, why the ball, being let out of your hand, does not fall on this or that side, or move upwards, but falls directly towards the centre of the earth, by that shortest line, (which mechanicians call *linea directionis*) which is the diameter of the earth prolonged to the centre of gravity of the ball? It will be readily answered, that this proceeds from the ball's gravity, *i. e.* an innate appetite, whereby it tends to the centre of the earth the nearest way. But then I demand, whence comes this rebound, *i. e.* this motion upwards? for it is plain, it is the genuine consequence of the motion downwards, and therefore is increased according as that motion in the ball was increased by falling from a greater height: so that it seems, that nature does, in such cases, play a very odd game, since she forces a ball, against the laws of heavy bodies, to ascend divers times upwards,

upon the account of that very gravity, whose office it is to carry it downwards the directest way; and, at least, she seems, in spite of the wisdom ascribed to her, to take her measures very ill, in making the ball move downwards with so much violence, as makes it divers times fly back from the place she intended it should go to; as if a ball, which a child can play with, and direct as he pleases, were so unweildy a thing, that nature cannot manage it, without letting it be hurried on with far greater violence, than her design requires.

THE reflection I have been making on a ball may (*mutatis mutandis*, as they speak) be applied to a pendulum. For, since it is unanimously affirmed by all, that have written of it, that it falls to the perpendicular, upon the account of its gravity; it must not be denied, that it is from a motion proceeding from the same gravity, that the swinging weight passes beyond the perpendicular, and consequently ascends, and oftentimes makes a multitude of diadroms, or vibrations; and consequently does very frequently ascend, before it comes to rest in the perpendicular; which is the position, wherein its gravity is best complied with, and which therefore it had been best settled in at first.

I SHALL not here mention those grand anomalies, or exorbitances, even in the vaster bodies of the universe; such as earthquakes, that reach some hundreds of leagues, deluges, destructive eruptions of fire, famines of a large spread, raging pestilencies, coelestial comets, spots in the sun, that are recorded to have obscured it for many months; the sudden appearing, the disappearing, and the re-appearing of stars, that have been judged to be as high as the region of the fixed ones: I will not, I say, inquire, how far these anomalies agree to the character wont to be given of nature's watchfulness and vigilancy; because probably I may have hereafter a fit opportunity to do it, and must now proceed to the remaining instances I promised you, which are taken from what happens to animals, as soon as I shall have dispatched some considerations and advertisements, that seem necessary to be premised to what I have to offer about that difficult subject.

If the past discourse give rise to a question, *Whether the world, and the creatures, that compose it, are as perfect as they could be made?* The question seems to me, because of the ambiguity of the terms, too intricate to be resolved by a single answer: but yet, because the problem is not wont to be discussed, and is, in my opinion, of moment, in reference to natural theology; I shall venture briefly to intimate some of the thoughts, that occurred to me about it; having first declared, that I am, with reason, very backward to be positive in a matter of this nature, the extent of the divine power and wisdom being such, that its bounds, in case it have any, are not known to me.

THIS premised, I consider, that the sense of the question may be, whether God could make the material world, and the corporeal creatures it consists of, better and more perfect than they are? Speaking in a general way and absolute sense: or else, whether the particular kinds or orders of the creatures, in the world, could any of them be made more perfect or better, than they have been made?

To answer the question in the first named sense of it, I think it very unsafe to deny, that God, who is almighty and omniscient, and an owner of perfections, which, for aught we know, are participable in more different manners and degrees, than we can comprehend, could not display, if it be not fitter to say adumbrate them, by creating a work more excellent than this work: and his immense power and unexhausted wisdom considered, it will not follow, either that because this world of ours is an admirable piece of workmanship, the divine architect could not have bettered it; or,

because God himself is able to make a greater master-piece, this exquisitely contrived system is not admirably excellent.

BUT the proposed question, in the other sense of it, will require some more words to resolve it. For if we look upon the several species of visible creatures under a more absolute consideration, without respect to the great system of the universe, of which they are parts, or to the more particular designs of the creator; it seems manifest, that many sorts of creatures might have been more perfect than they are, since they want many completing things, that others are endowed with: as an oyster, that can neither hear, nor see, nor walk, nor swim, nor fly, &c. is not so perfect a creature, as an eagle, or an elephant, that have both those senses, that the oyster wants, and a far more active faculty of changing places; and of this inequality of perfection in creatures of differing kinds, the examples are too obvious to need to be enumerated. But if the question be better proposed, and it be inquired, not whether God could have made more perfect creatures, than many of those he has made, for that it is plain he could do so, because he has done it; but whether the creatures were not so curiously and skilfully made, that it was scarce possible they could have been better made, with due regard to all the wise ends he may be supposed to have had in making them, it will be hard to prove a negative answer.

THIS I shall endeavour to illustrate by a supposition. If one should come into the well-furnished shop of an excellent watch-maker, and should there see a plain watch, designed barely to shew the hour of the day; another that strikes the hours; a third that is also furnished with an alarm; a fourth, that, besides these, shews the month current, and the day of it; and lastly, a fifth, that over and above all these, shews the motions of the sun, moon, and planets, the tides, and other things, which may be seen in some curious watches: in this case, I say, the spectator, supposing him judicious, would indeed think one of these watches far more excellent and compleat than another; but yet he would conclude each of them to be perfect in its own kind, and the plain watch to answer the artificer's idea and design in making it, as well as the more compounded and elaborate one did. The same thing may, in some circumstances, be further illustrated, by considering the copy of some excellent writing-master, for though there we may find some leaves written in an Italian hand, others in a secretary, and, in others, hands of other denominations; though one of these patterns may be much fairer, and more curious than another, if they be compared together; yet, if we consider their equal conformity to the respective ideas of the author, and the suitableness to the design he had of making each copy, not as curious, slightly and flourishing as he could, but as conformable to the true idea of the sort of hand he meant to exhibit, and the design he had to shew the variety, number and justness of his skill, by that of the patterns he made compleat in the respective kinds; we shall not think, that any of them could have been bettered by him: and if he should have made a text-hand as fair as a Roman hand, by giving it more beauty and ornament, he would not have made it better in its kind, but spoiled it, and, by a flourish of his skill, might have given a proof of his want of judgment.

BUT to return thither, whence I began to make this excursion, perhaps, *Eleutherius*, you will object against the examples I have produced before it, that the exceptions I have taken at some of the proceedings of nature, may be as well urged against providence, and exclude the one as well as the other from the government of the world.

BUT to this I answer, that this objection is foreign to the question, which is about men's notion of nature, not God's providence; which, if it were here my task to assert, I should establish it upon its proper and solid grounds; such as the infinite per-

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fections of the divine nature, which both engage and enable him to administer his dominion over all things; his being the author and supporter of the world; the exquisite contrivance of the bodies of animals, which could not proceed but from a stupendous wisdom; the supernatural revelations and discoveries he has made of himself, and of his particular care of his creatures, by prophecies, apparitions, true miracles, and other ways, that transcend the power, or at least over-rule the physical laws of motion in matter: by these, I say, and the like proper means, I would evince divine providence. But being not now obliged to make an attempt, which deserves to be made very solemnly, and not in such haste, as I now write in; I shall at present only observe to you, that the case is very differing between providence and nature, and therefore there is no necessity, that the objections I have made against the latter, should hold against the former. As, (to give you a few instances of the disparity) in the first place, it appears not, nor is it likely, that it is the design of providence to hinder those anomalies and defects, I have been mentioning; whereas it is said, to be the duty and design of nature, and her only task, to keep the universe in order, and procure, in all the bodies, that compose it, that things be carried on in the best and most regular way, that may be, for their advantage. Secondly, nature is confessed to be a thing inferior to God, and so but a subordinate agent, and therefore cannot, without disparagement to her power, or wisdom, or vigilancy, suffer divers things to be done, which may, without degradation to God, be permitted by him, who is not only a self-existent and independent Being, but the supreme and absolute Lord, and, if I may so speak, the proprietor of the whole creation; whence both *Melchizedec* and *Abram* stile him, (*Gen. xiv. 19, 23.*) not only the most high God, but *קנה koneh*, possessing (or, as our version has it, possessor of) heaven and earth; and who, when he made the world, and established the laws of motion, gave them to matter, not to himself: and so being obliged to none, either as his superior or benefactor, he was not bound to make, or administer, corporeal things after the best manner, that he could, for the good of the things themselves; among which, those, that are capable of gratitude, ought to praise and thank him for having vouchsafed them so much as they have, and have no right to except against his having granted them no more. And, as being thus obliged to none of his works, he has a sovereign right to dispose of them; so he has other attributes, which he may justly exercise, and both intend and expect to be glorified for, besides his goodness to inferior creatures: and his wisdom may be better set off to men, and perhaps to angels or intelligencies, by the great variety of his contrivancies in his works, than by making them all of the excellentest kind; as shadows in pictures, and discords in music, skilfully placed and ordered, do much recommend the painter and the musician. Perhaps it may be added, that the permitting the course of things to be somewhat violated shews, by the mischief such exorbitances do, how good God has been in settling and preserving the orderly course of things. Thirdly, as God is a most absolute and free, so he is an omniscient Being; and as, by his supreme dominion over the works of his hands, he has a right to dispose of them, as he thinks best for his own glory; so upon the score of his unfathomable wisdom, he may have designs, and, if I may so speak, reaches in the anomalies, that happen in the world, which we men are too short sighted to discern; and may exercise as much wisdom, nay, and as much providence (in reference to men, the noblest visible object of his providence) in sometimes (as in divine miracles) receding from what men call the laws of nature, as he did at first in establishing them: whereas the office of nature being but to preserve the universe in general, and particular bodies in it, after the best manner, that their respective conditions will permit; we know, what it is she aims at, and consequently can better discern,

cern, when she misses of her aims, by not well acting what is presumed to be her part. Fourthly, we must consider, that, as God is an independent, free and wise, so he is also a just agent; and therefore may very well be supposed to cause many irregularities and exorbitances in the world, to punish those, that men have been guilty of. And whereas nature is but a nursing mother to the creatures, and looks even upon wicked men, not in their moral but in their philosophical capacities, God expressly declares, in the sacred scriptures, that, upon *Adam's* fall, he *curst the ground, or earth, for man's sake*, Gen. iii. 17, 18. and that there is no penal evil in the city, that is not derived from him, *Amos* iii. 6. He is not over-ruled, as men are fain to say of erring nature, by the head-strong motions of the matter, but sometimes purposely over-rules the regular ones, to execute his justice; and therefore plagues, earthquakes, inundations, and the like destructive calamities, though they are sometimes irregularities in nature, yet for that very reason they are designed by providence, which intends, by them, to deprive wicked men of that life, or of those blessings of life, whereof their sins have rendered them unworthy. But, whilst I mention designs, I must not forget, that mine was only to give you a taste of the considerations, by which one may shew, that such things, as manifest nature to act unsuitably to the representation, that is made of her, may yet, when attributed to divine providence, be made out to have nothing inconsistent with it.

AND yet, somewhat further to clear this weighty matter, and particularly some things but briefly hinted in what I have been lately discoursing, I think it fit, before I descend to the particulars, that I am apt to employ against the vulgar notion of nature, to premise somewhat by way of caution, that I may do some right (though I can never do enough,) to divine providence; and take care betimes, that no use, injurious to it, may be made of any thing, that my argument hath obliged me, or will oblige me, to say about that imaginary thing, vulgarly called nature, either in this or the sixth section, or any other part of our present inquiry.

I CONCEIVE then, that the divine author of things, in making the world, and the particular creatures, that compose it, had respect to several ends; some of them knowable by us men, and others hid in the abyss of the divine wisdom and counsels; and that of those ends, which are either manifest to us, or at least discoverable by human sagacity and industry, some of the principles are, the manifestation of the glory of God, the utility of man, and the maintenance of the system of the world, under which is comprized, the conservation of particular creatures, and also the propagation of some kinds of them.

BUT this general design of God, for the welfare of man and other creatures, is not (as I conceive) to be understood, but with a twofold limitation.

For first, though men, and other animals, be furnished with faculties or powers, and other requisites, to enable them to preserve themselves, and procure what is necessary for their own welfare; yet this provision, that God has been pleased to make for them, is made with reference to what regularly, or what most usually, happens to beings of that species or sort, that they belong to, but not with regard to such things as may happen to them irregularly, contingently, and (in comparison of the others,) unfrequently. Thus it is, in general, far better for mankind, that women, when they are brought to bed, should have their breasts filled with milk, to give suck to the new born babe, than that they should not; though sometimes, as if the child die in the delivery, or presently after, and in some other cases also, the plentiful recourse of milk to the mother's breasts proves troublesome and inconvenient, and sometimes also dangerous to her. Thus a head of hair is, for the most part, useful to the person, whether man or woman, that nature has furnished with it; though in some cases

cases (as of consumptions, and in a few other circumstances) it happens to be prejudicial to the wearer; and therefore physicians do often, with good success, prescribe, that it be shaven off. Thus the instinct, that hens have to hatch their eggs and take care of their young, is, in general, very useful, if not necessary, for the conservation of that species of birds; and yet it sometimes misguides and deludes them, when it makes them take a great deal of pains to brood upon those duck-eggs, that housewives, (having taken away the bird's own eggs) lay in her nest, which makes her very solicitous to hatch and take care of ducklings, instead of chickens. Thus it is an institution, that ordinarily is profitable for man, that his stomach should nauseate or reject things, that have a loathsome taste or smell, because the generality of those things, that are provided for his nourishment, are well, or, at least, not ill tasted; and yet, on some occasions of sickness, that disposition of the stomach to refuse, or vomit up, nauseous purges, and other distasteful medicines, (as such remedies are usually loathsome enough) proves very prejudicial, by being a great impediment to the recovery of health. And thus (to be short) the passions of the mind, such as fear, joy and grief, are given to man, for his good, and, when rightly used, are very advantageous, if not absolutely necessary, to him; though, when they grow unruly, or are ill-managed, as it but too often happens, they frequently prove the causes of diseases, and of great mischief, as well to the passionate man himself, as to others.

THE second limitation (which has a natural connexion with the former,) is this; that the omniscient author of things, who, in his vast and boundless understanding, comprehended at once the whole system of his works, and every part of it, did not mainly intend the welfare of such or such particular creatures, but subordinated his care of their preservation and welfare to his care of maintaining the universal system and primitive scheme or contrivance of his works, and especially those Catholic rules of motion, and other grand laws, which he at first established among the portions of the mundane matter. So that, when there happens such a concurrence of circumstances, that particular bodies, fewer or more, must suffer, or else the settled frame, or the usual course of things, must be altered, or some general law of motion must be hindered from taking place; in such cases, I say, the welfare and interest of man himself (as an animal) and much more that of inferior animals, and of other particular creatures, must give way to the care, that providence takes of things of a more general and important nature or condition.

THUS (as I formerly noted) God established the lines of motion, which the sun and the moon observe, though he foresaw, that from thence there would necessarily, from time to time, ensue eclipses of those luminaries; which he chose rather to permit, than to alter that course, which, on several accounts, was the most convenient. Thus a blown bladder, or a foot ball, falling from a considerable height upon the ground, rebounds upwards, and so, contrary to the nature of heavy bodies, moves from the centre of the earth, lest the Catholic laws of motion, whereby the springiness and reflection of bodies, in such circumstances, are established, should be violated or intrenched upon.

THUS, he thought not fit to furnish sheep with paws or tusks, or swiftness, or animosity, or craft, to defend or preserve themselves from wolves, and foxes, and other beasts of prey. And tame and fearful birds, such as hens, are so ill provided for defence, that they seem designed to be the food of hawks, kites, and other rapacious ones. Thus oysters, having neither eyes nor ears, are not near so well provided for, as the generality of beasts and birds, and even most other fishes. And thus silkworms (to name no other caterpillars,) usually (at least in these countries,) live not

much

much above half a year, being less furnished with the requisites of longevity, than the generality of birds, and beasts, and fishes.

I HAVE thought fit to lay down the two foregoing limitations, partly because they will be of use to me hereafter, and partly because they contain something, that may be added to what hath been lately represented on behalf of the divine providence (as it falls under the naturist's consideration.) For by these limitations we may perceive, that it is not just presently to deny, or censure the providence of God, whenever we see some creatures less compleatly furnished to maintain themselves; or some cases less provided for, than we think they might be; or seeming anomalies permitted, which we look upon as mischievous irregularities: for the welfare of men, or of this or that other particular sort of creatures, being not the only, nor, in likelihood, the principal end of God, in making the world; it is neither to be admired nor reprehended, that he has not provided for the safety and conveniency of particular beings any further, than well consists with the welfare of beings of a more considerable order, and also will comport with his higher ends, and with the maintenance of the more general laws and customs, settled by him among things corporeal. So that divers seeming anomalies and incongruities, whence some take occasion to question the administration of things, and to deny the agency of providence, do not only comport with it, but serve to accomplish the design of it.

I HAVE the more expressly declared my mind on this occasion, because, indeed, of the two main reasons, which put me upon so difficult a work, as I foresaw this treatise would be, as one was the love I bear to truth and philosophical freedom; so the other was a just concern for religion. For thinking it very probable, that in so inquisitive an age as this, some observations, like mine, about nature itself, might come into the minds of persons ill affected to divine providence, who would be glad and forward to wrest them, and make a perverse use of them; I thought it better, that such notions should be candidly proposed by one, that would take care to accompany them with those cautions, that may keep them from being injurious to religion.

HAVING premised the two foregoing advertisements to obviate misconstructions, I hope I may now safely proceed to particulars; whereof, for brevity's sake, I shall here mention but a few, leaving you to add to them those others, that occur in other parts of this treatise.

IN the first place then, I shall take notice, that there are several instances of persons, that have been choaked with a hair, which they were unable, either to cough up, or swallow down. The reason of this fatal accident is probably said to be the irritation, that is made by the stay of so unusual a thing, as a hair, in the throat; which irritation occasions very violent and disorderly, or convulsive motions to expel it, in the organs of respiration, by which means the continual circulation of the blood, necessary to the life of man, is hindered, the consequence whereof is speedy death. But this agrees very ill with the vulgar supposition of such a kind and provident being, as they represent nature, which is always at hand to preserve the life of animals, and succour them in their (physical) dangers and distresses, as occasion requires: for since a hair is so slender a body, that it cannot stop the throat so, as to hinder either the free passage of meat and drink into the stomach, or that of the air to or from the lungs, (as may be argued from divers no-way mortal excrescences and ulcers in the throat;) were it not a great deal better for nature to let the hair alone, and stay until the juices of the body have resolved or consumed it, or some favourable accident have removed it, than, like a passionate and transported thing, oppose it like a fury with such blind violence, as, instead of ejecting the hair, expels the life of him, that was troubled with it?

How

How the care and wisdom of nature will be reconciled to so improper and disorderly a proceeding, I leave her admirers to consider. But it will appear very reconcileable to providence, if we reflect back upon the lately given advertisement: for, in regard of the use and necessity of deglutition, and in many cases of coughing and vomiting, it was, in the general, most convenient, that the parts, that minister to these motions, should be irritated by the sudden sense of things, that are unusual, though perhaps they would not be otherwise dangerous or offensive; because (as we formerly noted,) it was fit, that the providence of God should, in making provision for the welfare of animals, have more regard to that, which usually and regularly befalls them, than to extraordinary cases or unfrequent accidents.

THOUGH most women are offended with the stink of the smoaking wick of a candle, which is no more than men also are; yet it has been frequently observed, that big-bellied women have been made to miscarry by the smell of an extinguished candle, which would before have indeed displeased, but not endangered, the same persons: so that it seems nature is, in these cases, very far from being so prudent and careful, as men are wont to fancy her; since by an odour, (which, if calmly received, would have done no harm to the teeming woman,) she is put into such unruly transports; and instead of watching for the welfare of the teeming woman, whose condition needed a more than ordinary measure of her care and tenderness, she violently precipitates her poor charge into a danger, that oftentimes proves fatal, not only to the mother, but the child also.

THE improper, and oftentimes hurtful, courses, that nature takes in persons, that are sick, some of one disease, some of another, will be hereafter taken notice of in opportune places; and therefore, for the present, I shall only observe, that nature seems to do her work very weakly, or bunglingly, in the production of monsters, whose variety and numerosness is almost as great, as their deformity, or their irregularity; insomuch that several volumes have been written, and many more might have been, to give the description of them. How these gross aberrations will agree with that great uniformity, and exquisite skill, that is ascribed to nature in her seminal productions, I leave the naturists to make out. I know, that some of them lay the fault upon the stubbornness of the matter, that would not be obsequious to the plastic power of nature; but I can hardly admit of this account from men of such principles, as they are, that give it: for it is strange to me, they should pretend, that nature, which they make a kind of semi-deity, should not be able to mould and fashion so small, and soft, and tractable, a portion of matter, as that, wherein the first model and efformation of the embryo is made; when, at the same time, they tell us, that it is able, in sucking pumps, to raise, and, if need be, sustain whole tons of water, to prevent a vacuum; and can, in mines, toss up into the air houses, walls, and castles, and perhaps the rocks they are built on, to give the kindled gunpowder the expansion, that its new state requires.

OTHER arguments, that, by a light change and easy application, may be made use of and added to these, against the vulgar notion of nature, may be met with in divers parts of this treatise, and especially in the VIIth section; for which reason (among others) I decline lengthening this part of my discourse, with the mention of them.

I FORESEE it may be said, that unless we admit such a being, as nature, to contrive and manage things corporeal, and in a regular and methodical way direct them to their respective ends, there will appear no visible footsteps or proof of a divine wisdom in the corporeal world: and this argument, I confess, is so specious, that it was one of the things, that made me the longest hesitate, what I should think of the received notion

of nature. But having further considered the matter, I saw it might be answered, that the curious contrivance of the universe and many of its parts, and the orderly course of things corporeal, with a manifest tendency to determinate ends, are matters of fact, and do not depend upon the supposition of such a being, as they call nature; but setting aside this or that hypothesis, may be known by inspection, if those, that make the inspection, be attentive and impartial: as when a man sees a human body skilfully dissected by a dexterous anatomist, he cannot, if he be intelligent and unprejudiced, but acknowledge, that there is a most curious and exquisite contrivance in that incomparable engine, and in the various parts of it, that are admirably fitted for distinct and determinate functions or uses. So that I do not at all, nor indeed can, suppress the manifest tokens of wisdom and design, that are to be observed in the wonderful construction and orderly operations of the world and its parts; but I endeavour to refer these indications of wisdom to the true and proper cause. And whereas, in the hypothesis of the objectors, there may be three causes assigned of these specimens or footsteps of wisdom; namely, God, nature, and chance; if, according to the doctrine by me proposed, nature be laid aside, the competition will remain only between God and chance; and sure he must be very dull, or very strongly prejudiced, that shall think it reasonable to attribute such admirable contrivances and such regular conducts, as are observable in the corporeal world, rather to chance, (which is a blind and senseless cause, or indeed no proper cause at all, but a kind of *ens rationis*) than to a most intelligent being, from which the curiousest productions may with congruity be expected: whereas, if such a celebrated thing, as nature is commonly thought, be admitted, it will not be near so easy to prove the wisdom (and consequently the existence) of God by his works, since they may have another cause, namely, that most watchful and provident being, which men call nature. And this will be especially difficult in the Peripatetic hypothesis of the eternity (not of matter only, for in that the atomist and others agreed with them, but) of the world: for, according to this account of the universe, there appears no necessity, that God should have any thing to do with it, since he did not make this automaton, but it was always self-existent, not only as to matter, but to form too; and as for the government or administration of the bodies it consists of, that is the proper business of nature. And if it be objected, that this being is by its assertors acknowledged to be subordinate to God; I shall answer, that as, upon the reasons and authorities I elsewhere delivered, it may justly be questioned, whether many philosophers, and perhaps some sects of them, who are adorers of nature, confessed her to be but the substitute of a superior being? So this distinction and subordination is not so easy to be proved against those, that side with those other antient philosophers, who either acknowledged no such thing, or expressly denied it: besides that this objection supposes the existence and superiority of a Deity, which therefore needs to be proved by other ways; whereas in the hypothesis I propose, the same phænomena, that discover admirable wisdom and manifest designs in the corporeal world, do themselves afford a solid argument, both of the existence and of some of the grand attributes of God, with which the rest, that properly belong to him, have a necessary connexion.

S E C T. VI.

V. **H**AVING, in the foregoing section, proposed some of the considerations, that have dissatisfied me with the received notion of nature, it may now be justly expected, that I should also consider, what I foresee will be alledged in its behalf, by the more intelligent of its favourers: and I shall not deny the objections I am going

to name to be considerable, especially for this reason, that I am very unwilling to seem to put such an affront upon the generality as well of learned men as of others, as to maintain, that they have built a notion of so great weight and importance upon slight and inconsiderable grounds.

THE reasons, that I conceive may have induced philosophers to take up, and rely on, the received notion of nature, are such as these, that follow :

AND the first argument, as one of the most obvious, may be taken from the general belief, or, as men suppose, observation, that divers bodies, as particularly earth, water, and other elements, have each of them its natural place assigned it in the universe; from which place, if any portion of the element, or any mixt body, wherein that element predominates, happens to be removed, it has a strong incessant appetite to return to it; because, when it is there, it ceases either to gravitate, or (as some schoolmen speak) to levitate, and is now in a place, which nature has qualified to preserve it, according to the axiom, that *locus conservat locatum*.

To this argument I answer, that I readily grant, that there being such a quantity of very bulky bodies in the world, it was necessary they should have places adequate to their bigness; and it was thought fit by the wise architect of the universe, that they should not be all blended together, but that a great portion of each of them should, at the beginning of things, be disposed of and lodged in a distinct and convenient place. But when I have granted this, I see not any necessity of granting likewise, what is asserted in the argument above proposed: for inanimate bodies having no sense or perception, (which is the prerogative of animadversive beings) it must be all one to them in what place they are, because they cannot be concerned to be in one place rather than in another, since such a preference would require a knowledge, that inanimate things are destitute of; and, for the same reason, a portion of an element, removed by force or chance, from what they call its proper place, can have no real appetite to return thither: for, who tells it, it is in an undue place, and that it may better its condition by removing into another? And who informs it, whether that place lies on this hand of it, or that hand of it, or above it, or beneath it? Some philosophers indeed have been somewhat aware of the weakness of the argument drawn from the vulgarly proposed instance (which yet is the best that is wont to be employed) of earthy bodies, which being let fall from the top of a house, or thrown into the air, do of themselves fall in a direct line towards the centre of the earth; and therefore they have strengthened this argument, as far as might be, by pretending, that these bodies have not indeed, as former philosophers were wont to think, an appetite to descend to the centre of the earth, but to the great mass of their connatural bodies. I will not therefore accuse these philosophers of the inconsiderate opinion of their predecessors, who would have nature make all heavy things affect to lodge themselves in the centre of the earth, which (as was formerly noted) being but a point, cannot contain any one of them, (how little soever it be;) but yet the hypothesis of these moderns is liable, though not to that, yet to other weighty objections.

FOR the first argument I lately employed will hold good against these philosophers too, it not being conceivable, how an inanimate body should have an appetite to rejoin homogeneous bodies, neither whose situation, nor whose distance from it, it does at all know.

SECONDLY, It does not appear, that all bodies have such an appetite, as is presumed, of joining themselves to greater masses of connatural bodies; as if you file the end of an ingot or bar of silver or of gold, the filings will not stick to their own mass, though it be approached never so near, or made to touch them; and much less will they leap to it, when it is at a distance from them. The like may be said almost

of all consistent bodies we are acquainted with, except the loadstone and iron, and bodies, that participate of one of those two.

THIRDLY, It is obvious to them, that will observe, that that, which makes lumps of earth, or terrestrial matter, fall through the air to the earth, is some general agent, whatever that be, which, according to the wise disposition of the author of the universe, determines the motion of those bodies we call heavy, by the shortest ways, that are permitted them, towards the central part of the terraqueous globe; whether the body, put into motion downwards be of the same, or a like, or a quite differing nature, from the greater mass of matter, to which when it is aggregated, it rests there. If, from the side of a ship you let fall a chip of wood out of your hand, when your arm is so stretched out, that the perpendicular, or shortest line, between that and the water, lies never so little without the ship, that chip will fall into the sea, which is a fluid body, and quite of another nature than itself, rather than swerve in the least from the line of direction, as mechanicians call it, to rejoin itself to the great bulk of wood, whereof the ship, though never so big, consists. And, on the other side, if a man, standing upon the shore just by the sea, shall pour out a glass of water, holding the glass just over his feet, that water will fall into the sand, where it will be immediately soaked up and dispersed, rather than deviate a little, to join itself to so great a mass of connatural body, as the ocean is.

* See the
Appendix
to the Hy-
drostat.
Paradoxes.

AND as to what is generally believed, and made part of the argument, that I am answering, that water does not weigh in water, because it is in its own natural place, and *elementa in proprio loco non gravitant*; I deny the matter of fact, and have convinced divers curious persons by experiment, * that water does gravitate in water, as well as out of it, though indeed it does not prægravitate, because it is counter-balanced by an equal weight of collateral water, which keeps it from descending.

AND lastly, for the maxim, that *locus conservat locatum*, besides that it has been prooflessly asserted, and therefore, unless it be cautiously explained, I do not think myself bound to admit it; besides this, I say, I think, that either the proper place of a body cannot be inferred, as my adversaries would have it, from the natural tendency of a body to it; or else it will not hold true in general, that *locus conservat locatum*: as when, for instance, a poor unlucky seaman falls from the main-yard of a ship into the water, does the sea, to which he makes such haste, preserve him or destroy him? And when, in a foul chimney, a lump of soot falls into the hearth, and presently burns up there; can we think, that the wisdom of nature gave the soot an appetite to hasten to the fire, as a greater bulk of its connatural body, or a place provided by nature for its conservation?

AND now I speak of such an innate appetite of conjunction between bodies, I remember, what I lately forgot to mention in a fitter place; that bubbles themselves may overthrow the argument I was answering. For if a bubble happens to arise from the bottom of a vessel to the upper part of it, we are told, that the haste, wherewith the air moves thorough water, proceeds from the appetite it has to quit that preternatural place, and rejoin the element, or great mass of air, detained at the very surface of the water by a very thin skin of that liquor, together with which it constitutes a bubble. Now I demand, how it comes to pass, that this appetite of the air, which when it was at the bottom of the water, and also in its passage upwards, is supposed to have enabled it to ascend with so much eagerness and force, as to make its way thorough all the incumbent water, (which possibly was very deep,) should not be able, when the air is arrived at the very top of the water, to break through so thin a membrane of water, as usually serves to make a bubble, and which suffices to keep it from the beloved conjunction with the great mass of the external air? Especially since they

they tell us, that natural motion grows more quick, the nearer it comes to the end or place of rest; the appetites of bodies encreasing with their approaches to the good they aspire to; upon which account, falling bodies, as stones, &c. are said (though falsely) to encrease their swiftness, the nearer they come to the earth. But if, setting aside the imaginary appetite of the air, we attribute the ascension of bubbles to the gravity and pressure upwards of the water, it is easy hydrostatically to explicate, why bubbles often move slower, when they come near the surface of the water, and why they are detained there; which last phenomenon proceeds from this, that the pressure of the water being there inconsiderable, it is not able to make the air quite surmount the resistance made by the tenacity of the superficial part of the water; and therefore in good spirit of wine, whose tenacity and glutinousness is far less than that of water, bubbles rarely continue upon the surface of the liquor, but are presently broken and vanish.

AND to make this presumed appetite of the smaller portions of the air to unite with the great mass of it, appear the less probable; I shall add, that I have often observed, that water, in that state, which is usually called its natural state, is wont to have store of ærial particles mingled with it, notwithstanding the neighbourhood of the external air, that is incumbent on the water; as may appear by putting a glass full of water into the receiver of the new pneumatical engine: for the pressure of the external air being by the pump taken off, there will, from time to time, disclose themselves in the water a multitude of bubbles, made by the ærial particles, that lay concealed in that liquor.

AND I have further tried, as I doubt not but some others also have done, that by exactly inclosing in a conveniently shaped glass some water, thus freed from the air, and leaving a little air at the top of the vessel, which was afterwards set by in a quiet place; the corpuscles of that incumbent air did, one after another, insinuate themselves into the water, and remained lodged in it; so little appetite has air, in general, to flee all association with water, and make its escape out of that liquor; though, when sensible portions of it happen to be under water, the great inequality in gravity between those two fluids makes the water press up the air. But though it were easy to give a mechanical account of the phenomena of mingled air and water; yet, because it cannot be done in few words, I shall not here undertake it, the phenomena themselves being sufficient to render the supposition of my adversaries improbable.

ANOTHER argument, in favour of the received opinion of nature, may be drawn from the strong appetite, that bodies have to recover their natural state, when by any means they are put out of it, and thereby forced into a state, that is called preternatural; as we see, that air being violently compressed in a blown bladder, as soon as the force is removed, will return to its first dimensions; and the blade of a sword being bent, by being thrust against the floor, as soon as the force ceases, restores itself, by its innate power, to its former straightness; and water, being made hot by the fire, when it is removed thence, hastens to recover its former coldness.

BUT though I take this argument to have much more weight in it, than the foregoing, because it seems to be grounded upon such real phenomena of nature, as those newly recited, yet I do not look upon it as cogent.

IN answer to it therefore, I shall represent, that it appears by the instances lately mentioned, that the proposers of the argument ground it on the affections of inanimate bodies. Now, an inanimate portion of matter being confessedly devoid of knowledge and sense, I see no reason, why we should not think it incapable of being concerned to be in one state or constitution, rather than another; since it has no knowledge

knowledge of that, which it is in at present, nor remembrance of that, from which it was forced; and consequently no appetite to forsake the former, that it may return to the latter: but every inanimate body, (to say nothing now of plants and brute animals, because I want time to launch into an ample discourse) being of itself indifferent to all places and states, continues in that place or state, to which the action and resistance of other bodies, and especially contiguous ones, effectually determine it.

As to the instance afforded by water, I consider, that before it be asserted, that water, being heated, returns of itself to its natural coldness, it were fit, that the assertors should determine, what degree or measure of coldness is natural to that liquor, and this, if I mistake not, will be no easy task. It is true indeed, that, in reference to us men, water is usually cold, because its minute parts are not so briskly agitated, as those of the blood and juices, that are to be found in our hands, or other organs of feeling; but that water is actually cold in reference to frogs, and those fishes, that live in it, whose blood is cold as to our sense, has not, that I know of, been proved, nor is easy to be so. And I think it yet more difficult to determine, what degree of coldness is natural to water, since this liquor perpetually varies its temperature, as to cold and heat, according to the temper of the contiguous or the neighbouring bodies, especially the ambient air. And therefore the water of an unshaded pond, for instance, though it rests in its proper and natural place, as they speak, yet in autumn, if the weather be fair, the temperature of it will much vary in the compass of the same day, and the liquor will be much hotter at noon, than early in the morning, or at midnight; though this great diversity be the effect only of a natural agent, the sun, acting according to its regular course. And, in the depth of winter, it is generally confessed, that water is much colder, than in the heat of summer; which seems to be the reason of what is observed by watermen, as a wonderful thing, namely, that, in rivers, boats equally laden will not sink so deep in winter, as in summer, the cold condensing the water, and consequently making it heavier in specie, than it is in summer, when the heat of the ambient air makes it more thin. In divers parts of *Africk*, that temperature is thought natural to the water, because it is that, which it usually has, which is far hotter than that, which is thought natural to the same liquor in the frigid zone. And, I remember, on this occasion, what perhaps I have elsewhere mentioned upon another, that the Russian Czar's chief physician informed me, that in some parts of *Siberia*, (one of the more northern provinces of that monarch's empire, water is so much more cold, not only than in the torrid zone, but than in *England*, that two or three foot beneath the surface of the ground, all the year long (even in summer itself,) it continues concentered in the form of ice; so intense is the degree of cold, that there seems natural to it. This odd phenomenon much confirms, what I lately intimated of the power of contiguous bodies, and especially of the air, to vary the degree of the coldness of water. I particularly mention the air, because, as far as I have tried, it has more power to bring water to its own temperature, than is commonly supposed: for though, if in summer-time, a man puts his hand into water, that has lain exposed to the sun, he will usually feel it cold, and so conclude it much colder, than the ambient air; yet that may often happen upon another account, namely, that the water being many hundred times a more dense fluid than the air, and consisting of particles more apt to insinuate themselves into the pores of the skin, a greater part of the agitation of the blood and spirits contained in the hand is communicated to the water, and thereby lost by the fluids, that part with it: and the minute particles of the water, which are, perhaps, more supple and flexible, insinuating themselves into the pores of the skin, which the ærial particles, by reason of their stiffness, and

and perhaps length, cannot do; they come to affect the somewhat more internal parts of the hand, which, being much hotter, than the cuticula or scarf-skin, makes us feel them very cold; as, when a sweating hand is plunged into luke-warm water, the liquor will be judged cold by him, who, if his other hand be very cold, will with it feel the same water hot. To confirm which conjecture I shall add, that having sometimes purposely taken a sealed weather-glass, whose included liquor was brought to the temperature of the ambient air, and thrust the ball of it under water kept in the same air, there would be discovered no such coldness in the water as one would have expected; the former reason of the sensible cold the hand feels, when thrust into that liquor, having here no place. To which I shall add, that having, for trial's sake, made water very cold, by dissolving sal-armoniac in it, in summer-time, it would, after a while, return to its usual degree of warmth; and having made the same experiment in winter, it would return to such a coldness as belonged to it in that season: so that it did not return to any determinate degree of coldness, as natural to it; but to that, greater or lesser, that had been accidentally given to it by the ambient air, before the sal-ammoniac had refrigerated it.

As to the motion of restitution, observed upon the removal or ceasing of the force in air violently compressed, and in the blade of a sword forcibly bent, I confess it seems to me a very difficult thing to assign the true mechanical cause of it, but yet I think it far more likely, that the cause should be mechanical, than that the effect proceeds from such a watchfulness of nature as is pretended. For, first, I question whether we have any air here below, that is in other than a preternatural or violent state; the lower parts of our atmospherical air being constantly compressed by the weight of the upper parts of the same air, that lean upon them.

As for the restitution of the bent blade of a sword, and such like springy bodies, when the force that bent them is removed; my thoughts about the theory of springiness belong to another paper. And therefore, I shall here only, by way of argument *ad hominem*, consider, in answer to the objection, that if, for example, you take a somewhat long and narrow plate of silver, that has not been hammered or compressed, or, which is surer, has been made red-hot in the fire, and suffered to cool leisurely, you may bend it which way you will, and it will constantly retain the last curved figure that you gave it: but if, having again straightened this plate, you give it some smart strokes of a hammer, it will, by that merely mechanical change, become a springy body; so that, if with your hand you force it a little from its rectitude, as soon as you remove your hand it will endeavour to regain its former straightness. The like may be observed in copper, but nothing near so much, or scarce at all, in lead. Now, upon these phænomena, I demand, why, if nature be so careful to restore bodies to their former state, she does not restore the silver blade or plate to its rectitude, when it is bent this way or that way, before it is hammered? And why a few strokes of a hammer (which, acting violently, seems likely to have put the metal into a preternatural state) should entitle the blade to nature's peculiar care, and make her solicitous to restore it to its rectitude, when it is forced from it? And why, if the springy plate be again ignited and refrigerated of itself, nature abandons her former care of it, and suffers it quietly to continue in what crooked posture one pleases to put it into? Not, now, to demand a reason of nature's greater partiality to silver, and copper and iron, than to lead and gold itself, in reference to the motion of restitution; I shall add to what I was just now saying, that even in sword-blades it has been often observed, that though, if soon after they are bent, the force, that bent them, be withdrawn, they will nimbly return to their former straightness; yet, if they (which are not the only springy bodies of which this has been observed) be kept too
long

long bent, they will lose the power of recovering their former straightness, and continue in that crooked posture, though the force, that put them into it, cease to act: so that, it seems, nature easily forgets the care she was presumed to take of it at first.

THERE is an axiom, that passes for current among learned men, *viz. nullum violentum durabile*, that seems much to favour the opinion of the naturists, since it is grounded upon a supposition, that what is violent is, as such, contrary to nature, and, for that reason, cannot last long. And this trite sentence is, by the schools and even some modern philosophers, so particularly applied to local motion, that some of them have, not improbably, made it the characteristic token, whereby to distinguish natural motions from those that are not so; that the former are perpetual, or at least very durable; whereas the latter, being continually checked more and more by the renitency of nature, do continually decay, and within no long time are suppressed or extinguished: but, on this occasion, I must crave leave to make the following reflections:

1. IT may be justly questioned, upon grounds laid down in another part of this essay, whether there be any motion among inanimate bodies that deserves to be called violent, in contradistinction to natural; since, among such, all motions, where no intelligent spirit intervenes, are made according to catholic, and almost, if not more than almost, mechanical laws.

2. METHINKS the Peripatetics, who are wont to be the most forward to employ this axiom, should find but little reason to do so, if they consider how unsuitable it is to their doctrine, that the vast body of the firmament and all the planetary orbs are, by the *primum mobile*, with a stupendous swiftness whirled about from East to West in four and twenty hours, contrary to their natural tendency; and that this violent and rapid motion of their incomparably greater part of the universe has lasted as long as the world itself, that is, according to *Aristotle*, for innumerable ages.

3. WE may observe here below, that the ebbing and flowing of the sea, which is generally supposed to proceed either from the motion of the moon or that of the terrestrial globe, or some other external cause, has lasted for some thousands of years, and probably will do so as long as the present system of our vortex shall continue. I consider also, that the other great ocean, the atmosphere, consists of numberless myriads of corpuscles, that are here below continually kept in a violent state; since they are elastical bodies, whereof the lower are still compressed by the weight of the higher. And to make a spring of a body, it is requisite, that it be forcibly bent or stretched, and have such a perpetual endeavour to fly open, or to shrink in, that it will not fail to do so, as soon as the external force that hindered it is removed. And as for the state of inanimate bodies, I do not see, that their being or not being natural can be, with any certainty, concluded from their being or not being very durable. For, not to mention that leaves, that wither in a few months, and even blossoms, that often fade and fall off in a few days, are as well natural bodies as the solid and durable trees that bear them; it is obvious, that, whether we make the state of fluidity, or that of congelation, to be that which is natural to water, and the other that which is violent; its change from one of those states into another, and even its return to its former state, is oftentimes, at some seasons, and in some places, made very speedily, perhaps in an hour or less, by causes that are acknowledged to be natural. And mists, hail, whirlwinds, lightning, falling stars, to name no more, notwithstanding their being natural bodies, are far from being lasting, especially in comparison of glass, wherein the ingredients, sand and fixed salt, are brought together by great violence of fire. And the motion, that a thin plate, or slender wire, of this glass can exercise, to restore itself to its former position, when
forcibly

forcibly bent, is (in great part) a lasting effect of the same violence of the fire: and so is the most durable perseverance of the indissolubleness of the alcalisate salt, that is one of the two ingredients of glass, notwithstanding its being very easily dissoluble in water and other liquors, and not uneasily even in the moist air itself.

THERE is a distinction of local motion into natural and violent, that is so generally received and used, both by philosophers and physicians, that I think it deserves to have special notice taken of it in this section; since it implicitly contains an argument for the existence of the thing called nature, by supposing it so manifest a thing, as that an important distinction may justly be grounded on it.

THIS implied objection, I confess, is somewhat difficult to clear; not for any great force that is contained in it, but because of the ambiguity of the terms wherein the distinction is wont to be employed: for most men speak of the proposed distinction of motion in so obscure or so uncertain a way, that it is not easy to know what they mean by either of the members of it. But yet some there are who endeavour to speak intelligibly, (and for that are to be commended) and define natural motion to be that, whose principle is within the moving body itself; and violent motion that, which bodies are put into by an external agent or cause. And in regard these speak more clearly than the rest, I shall here principally consider the lately mentioned distinction, in the sense they give it. I say then, that, even according to this explication, I am not satisfied with the distinction: for, whereas it is a principle received, and frequently employed by *Aristotle* and his followers, *Quicquid movetur ab alio movetur*; it seems that, according to this axiom, all motion may be called violent, since it proceeds from an external agent; and indeed, according to the school philosophers, the motion of far the greatest part of the visible world, though this motion be most regular and lasting, must, according to the proposed distinction, be reputed violent; since they assert, that the immense firmament itself, and all the planetary orbs, (in comparison of which vast cœlestial part of the world the sublunary part is little more than a physical point) is perpetually (and against its native tendency) hurried about the centre of the world once in twenty-fours, by an external though invisible agent, which they therefore call the *primum mobile*. And as for the criterion of natural motion, that its principle is within the moving body; it may be said, that all bodies, once in the state of actual motion, whatever cause first brought them to it, are moved by an internal principle: as, for instance, an arrow, that actually flies in the air towards a mark, moves by some principle or other residing within itself; for it does not depend on the bow it was shot out of, since it would continue though that were broken, or even annihilated; nor does it depend upon the medium, which more resists than assists its progress, as might be easily shewn, if it were needful; and if we should suppose the ambient air either to be annihilated, or (which in our case would be equivalent) rendered incapable of either furthering or hindering its progress, I see not why the motion of the arrow must necessarily cease, since in this case there remains no medium to be penetrated, and on that account oppose its progress. When in a watch, that is wound up, the spring endeavours to unbend or display itself; and when the string of a drawn bow is broken or let go, the spring of the former, and the woody part of the latter, does each return to a less crooked line: And though these motions be occasioned by the forcible acts of external agents, yet the watch-spring, and the bow, have in themselves (for aught appears to those I reason with) an inward principle, by which they are moved, till they have attained their position. Some perhaps would add, that a squib or a rocket, though an artificial body, seems, as well as a falling star, to move from an internal principle: but I shall rather observe, that, on the other side, external agents are requisite to many motions that are ac-

known to be natural; as, to omit the germination and flourishing of divers plants, as onions, leeks, potatoes, &c. though hung up in the air, by the heat of the sun in the spring; to pass by this, I say, if in the pneumatical engine or air-pump you place divers insects, as bees, flies, caterpillars, &c. and withdraw the common air from the receiver, they will lie moveless, as if they were dead, though it be for several hours, whilst they are kept from enjoying the presence of the air: but when the external air is permitted again to return upon them, they will presently be revived, (as I have with pleasure tried) and be brought to move again, according to their respective kinds; as if a fly, for instance, resembled a little windmill in this, that, being moveless of itself, it required the action of the air to put its wings and other parts into motion. But, to insist no farther on these arguments *ad hominem*, we may consider, that, since motion does not essentially belong to matter, as divisibility and impenetrableness are believed to do, the motions of all bodies, at least at the beginning of things, and the motions of most bodies, the causes of whose motions we can discern, were impressed on them, either by an external immaterial agent, God, or by other portions of matter (which are also extrinsical impellers) acting on them.

Natura est
Principi-
um quod-
dam &
Causa, cur
id movea-
tur &
quiescat,
in quo
inest, &c.
Aristot.
Anscult.
l. ii. c. 1.

AND this occasion invites me to observe, that though motion be deservedly made one of the principal parts of *Aristotle's* definition of nature, yet men are wont to call such motions natural, as are very hard to distinguish from those they call violent. Thus, when water falls down to the ground, they tell us that this motion is natural to that liquor, as it is a heavy body; but when a man spurts up water out of his mouth into the air, they pronounce that motion, because of its tendency upwards, to be contrary to nature. And yet when he draws water into his mouth, by sucking it through a long pipe held perpendicularly, they will have this motion of the water, though directly upwards, to be not violent, but natural. So when a foot-ball, or blown bladder, being let fall upon a hard floor, rebounds up to a good height, the descent and ascent are both said to be natural motions, though the former tends towards the centre of the earth, and the latter recedes as far as it can do from it. And so if from a considerable height you let fall a ball of some close wood, that yet is not too heavy, as oak or the like, into a deep vessel of water, it will descend a great way in that liquor, by a natural motion; and yet its contrary motion upwards ought not to be esteemed violent, since, according to the schools, being lighter in specie than water, it is natural to it to affect its proper place, for which purpose it must ascend to the top of the liquor, and lie afloat there; and yet it is from these tendencies to opposite points (as the zenith and the nadir) that men are wont to judge many motions of bodies to be natural or violent.

AND indeed, since it must be indifferent to a lifeless and insensible body to what place it is made to move, all its motions may in some respect be said to be natural, and in another violent: for as very many bodies of visible bulk are set a moving by external impellents, and on that score their motions may be said to be violent, so the generality of impelled bodies do move either upwards, downwards, &c. toward any part of the world, in what line or way soever they find their motion least resisted; which impulse or tendency being given by virtue of what they call the general laws of nature, the motion may be said to be natural.

I MIGHT here take notice that, according to the Epicurean hypothesis, it need not at all be admitted, that motion must be produced by such a principle as the schoolmen's nature: for, according to that great and antient sect of philosophers, the atomists, every indivisible corpuscle has actual motion, or an incessant endeavour to change places, essentially belonging to it as it is an atom; insomuch that in no case it can
be

be deprived of this property or power. And all sensible bodies being, according to these physiologists, but casual concretions or coalitions of atoms, each of them needs no other principle of motion than that unloseable endeavour of the atoms that compose it, and happen, on the account of circumstances, to have the tendency of the more numerous, or at least the predominant, corpuscles determined one way: and to these I might add some other such reflections. But I shall, in this place, say no more concerning motion, not only because, even after having considered the differing definitions that *Aristotle*, *Cartesius*, and some other philosophers, have given of it, I take it to be too difficult a subject to be clearly explicated in few words; but because the only occasion I had to mention it here was to shew, that the vulgar distinction of it into natural and violent is not so clear and well grounded as to oblige us to admit, (what it supposes) that there is such a being as the naturists assert.

I COME now to consider the argument that may be drawn in favour of the received notion of nature, from the critical evacuations which happen at certain times in diseases, and the strange shifts that nature sometimes makes use of in them, to free herself from the noxious humours that oppressed her.

THIS argument I willingly acknowledge to be very considerable: for we really see, that in continual fevers, especially in hotter climates, there do usually happen, at certain times of the diseases, notable and critical commotions or conflicts, after which the morbid matter is disposed of and discharged by ways strange and surprising, to the great and speedy relief of the patient, if not to his perfect cure; as may appear by many instances to be met with in the observations of physicians about fevers, pleurisies, &c. Upon this account I take the argument drawn from crises to be much the weightiest that can be urged for the opinion from which I dissent; and therefore I shall employ the more words in clearing this important difficulty.

IN order to this I desire it may be kept in mind, that I do not only acknowledge, but teach, that the body of a man is an incomparable engine, which the most wise Author of things has so skilfully framed for lasting very many years, that if there were in it an intelligent principle of self-preservation, (as the naturists suppose there is) things would not, in most cases, be better or otherwise managed, for the conservation of the animal's life, than they generally are. So that the question is not, whether there is a great deal of providence and wisdom exercised in the crises of diseases, but upon what account it is that these apposite things are performed? The universal opinion of physicians is, that it is that intelligent principle they call nature, which, being solicitous for the welfare of the patient, and distressed by the quantity or hurtfulness of the morbid matter, watches her opportunity (especially when it is concocted) to expel it hastily out of the body, by the most safe and convenient ways which, in the present condition of the patient, can be taken: and I, on the other side, attribute crises to the wisdom and ordinary providence of God, exerting itself by the mechanism partly of that great machine the world, and partly of that smaller engine the human body, as it is constituted in the patient's present circumstance; and the reasons, that hinder me from acquiescing in the general opinion of physicians about crises, are principally these:

FIRST, I observe, that crises, properly so called, do very seldom happen in other than fevers, and the like acute diseases, where, according to the common course of things, the malady is terminated, in no long time, either by recovery or death, or a change into some other disease: but chronical sicknesses, such as coughs, dropsies, gouts, &c. unless they happen to be accompanied with feverish distempers, are not wont to have crises; which argues, that nature doth not make critical evacuations upon the account of such care and watchfulness as physicians ascribe them to; since

she neglects to employ so salutary an expedient in diseases, that are oftentimes no less dangerous and mortal than divers acute diseases, which she attempts to cure by crises.

NEXT I consider, that critical evacuations may be procured by the bare mechanism of the body: for, by virtue of that, it will often happen, that the fibres, or motive organs of the stomach, bowels, and other parts, being distended or vellicated by the plenty or acrimony of the peccant matter, will, by that irritation, be brought to contract themselves vigorously, and to throw out the matter, that offends the parts, either by the emunctories or common-shores of the body, or by whatever passages the proscribed matter can be with more ease discharged. Thus, when some men find their stomachs burdened with a clog of meat or drink, they use to thrust their fingers into their throats, and by that mechanical way provoke the stomach to disburden itself of its offensive load, without being beholden to nature's watchfulness for a crisis, which probably she would not (at least so seasonably) attempt. And thus, whereas it is usual enough for crises to be made in fevers by large hæmorrhages at the nose, and sometimes at other parts, which is ascribed to nature's watchful solicitude for the patient's recovery; I must take leave to add, that it hath been divers times observed, that even after death large bleedings have succeeded at the nose and other parts of the body; which shews, that such excretions may be made by virtue of the structure of it, and the turgecence and acrimony of the humours, without any design of nature to save the life of the patient already dead.

INDEED, if it did appear by experience, that all, or almost all, the crises of diseases did either expel the morbid matter, or at least notably relieve the patient, the critical attempts of nature would much favour the opinion men have conceived of her vigilance and conduct: but unwelcome instances daily shew, that as some crises are salutary, (as they call them) so others prove mortal; and among those, that do not directly or presently kill the patient, there are divers that leave him in a worse condition than he was before. And therefore I wonder not, that physicians have thought themselves obliged to lay down several circumstances, as necessary requisites of a laudable crisis, if any of which be wanting, it is not thought of the best kind; and if the contrary to some of them happen, it is to be judged either pernicious, or at least hurtful. For, whereas there are two general ways supposed to be employed by nature in making crises, the one by expulsion of the peccant matter out of the body, and the other by the settling of the matter somewhere within it, neither of these two ways is constantly successful.

AND therefore experience hath obliged physicians to divide crises, not only into perfect, that fully determine the event of the disease; and imperfect, that do but alter it for the better or the worse: but into salutary, that quite deliver the patient; and mortal, that destroy him. And to a perfect and salutary crisis some learned men require no less than six conditions; namely, that it be preceded by signs of coction of the peccant matter; that it be made by a manifest and sufficiently copious excretion or translocation; that it be made upon a critical day, as the seventh, fourteenth, &c. that it leave no relicks behind it, that may endanger a relapse; that it be made safely, that is, without dangerous symptoms; and lastly, that it be suitable to the nature of the disease and the patient. By this it may appear, that it is no common thing to meet with a perfect and salutary crisis, so many laudable conditions must concur in it; and indeed nature doth usually take up with but imperfectly good ones, and it were happy if she made not better, provided she made no worse. But it is found by sad experience, that she rouses herself up to make a crisis, not only upon improper, and, as physicians call them, intercident days, such as the third, fifth,

fifth, ninth, &c. or upon those they call empty or medicinal days, which seldom afford any crisis, and much seldomer a good one; but also when there appear not any signs of coction, or at least of due coction, and by these unseasonable attempts weaken the patient, and increase the malady, or perhaps make it speedily mortal. Nor will it justify nature, to say, with some learned physicians, that these attempts are accidentally brought on by the acrimony or importunity of the morbid matter, by which she is provoked, before the time, to endeavour an expulsion of it: for if nature be indeed so prudent and watchful a guardian, as she is thought, she ought not to suffer herself to be provoked to act preposterously, and make furious attempts, that lavish to no purpose, or worse than no purpose, that little strength the patient hath so much need of. And therefore physicians do oftentimes very well, when to act agreeably to the dictates of prudence, they forget how much wisdom they are wont to ascribe to nature, and employ their best skill and remedies to suppress or moderate the inordinate motions, or the improper and profuse evacuations, that irritated nature rashly begins to make. And though the crises, that are made by a metastasis of the peccant matter, or by lodging it in some particular part of the body, whether external or internal, be oftentimes, when they are not salutary, somewhat less hurtful, than those, that are made by excretion: yet these do frequently, though perhaps more slowly, prove dangerous enough, producing sometimes inward imposthumes, and sometimes external tumors, in parts, that are either noble by their functions, or by their situation, or connexion, or sympathy with others, that are not to be without hazard or great inconvenience oppressed.

I know, that physicians make it a great argument of nature's providence and skill, that she watches for the concoction of the peccant matter, before she rouses herself up to expell it by a crisis. What is to be meant by this coction of humours (for it ought not to be confounded with the coction of the aliments) they are not wont so clearly to declare: but, as I understand it, when they say, that a portion of peccant matter is brought to coction, they mean, that it has acquired such a disposition, as makes it more fit, than before, to be separated from the sounder portion of the mass of blood, or from the consistent parts, to which it perhaps formerly adhered, and to be afterwards expelled out of the body. This may be partly exemplified by what happens in some recent colds, where the lungs are affected, in which we see, that after a few days the phlegm is made more fluid; and that which is lodged in the lungs, (not sticking so fast to the inside of the *aspera arteria*) is easily brought up by coughing, which could not dislodge it before. And in fevers, that separation in the urine, formerly cloudless, that physicians look upon as a good sign of coction, seems to be produced by some part of the peccant matter, that beginning to be separated from the blood, mingles with the urine, and is not usually distinguished from it, whilst this liquor is warm; but when it is grown cold, does, on the score of its weight or texture, somewhat recede, and appear in a distinct form, as of a cloud, a sediment, &c. But whatever they mean by coction, it is plain enough, by what hath been lately noted, that on many occasions, nature doth not wait for it, but unseasonably, and oftentimes dangerously, attempts to proscribe the matter, that offends her, before it be duly prepared for expulsion.

I come now to that circumstance of crises, that is thought the most wonderful, which is, that nature does oftentimes by very unusual ways, and at unexpected places, discharge the matter, that offends her, and thereby either cures, or notably relieves the patient: and it must not be denied, that, in some cases, the critical evacuations have somewhat of surprizing in them; and I shall also readily grant, that N. B. [Divine providence may expressly interpose, not only in the infliction of dis-

cases

eases by way of punishment, but in the removal of them in the way of mercy.] But setting aside these extraordinary cases, I think it not absurd to conjecture, that the performances of nature, in common crises, may be probably referred, partly to the particular condition of the matter to be expelled, and partly, (and indeed principally) to some peculiar disposition in the primitive fabric of some parts of the patient's body, or some unusual change made in the construction of these parts by the disease itself, or other accidents; which original or adventitious disposition of the sick man's body, not being visible to us, at least while he is alive, we are apt to ascribe the unexpected accidents of a crisis, if it prove salutary, to the wonderful providence of nature; and, if it happen to be other than salutary, we are wont to overlook them. To illustrate this matter, we may consider, that plentiful evacuations, procured by medicines, are a kind of artificial crises: we see, that some bodies are so constituted, that although the peccant humour, wrought on by the medicine, ought, as the physician thinks, to be expelled by siege, and indeed is wont to be so, in the generality of those, that take that kind of medicine, as, for instance, rhubarb or senna; yet the peculiar disposition of the patient's stomach will make that an emetic, which was intended to be, and regularly should be, a cathartic. Nor does this constitution of the stomach equally regard all purging medicines; for the same stomach, that will reject them in form, for instance, of a potion, will quietly entertain them, being in the form of pills. And to this let me add, what we observe of the operation of mercury; which though, if it be duly prepared, it is usually given to procure salivation especially to succulent bodies; yet there are some patients, wherein, instead of salivating, it will violently and dangerously work downwards, like a purge, or make some other unexpected evacuation. And I have seen a patient, who, though young and very fat, could not be brought to salivate, neither by the gentler ways, nor by turbith-mineral and other harsher medicines, though administered by very skilful physicians and chirurgeons. And this peculiarity may be as well contracted, as native: for some persons, especially after surfeits, having been roughly dealt with, or at least tired out with a medicine of this or that kind of form, will afterwards nauseate and vomit up the like medicine, though in other bodies it be never so far from being emetic. We see also, that sometimes sudorific medicines, instead of procuring sweat, prove briskly diuretic, and sometimes either purging or vomitive. From all this we may argue, that the quantities of the irritating matter, and much more the particular disposition of the patient's body, may procure evacuations at unexpected places. I remember too, that, among the observations I have met with of famous physicians, there are instances of periodical and critical evacuations, at very inconvenient, as well as unusual vents; as some women are recorded to have had their menses sometimes at the eyes, sometimes at the navel, and sometimes at the mouth; of which there seems no cause so probable, as some peculiar structure, whether native or adventitious, of the internal parts concerned in that discharge; and of such unusual structures anatomists must have seen many, since I myself have observed more than one or two. If these uncommon ways of disposing of the morbid matter were always salutary to the patient, the argument grounded on them would have more weight: but though most men take notice of this sort of crises but when they are lucky; yet an impartial observer shall often find, that ill-conditioned and hurtful crises may be made by unusual and unexpected ways. And, in some translations of the morbid matter to distant and nobler parts, perhaps it will be as difficult to shew, by what channels or known ways the matter passed from one to another, as it is to determine

determine, how it was conducted to those parts, at which it was the most happily vented.

IN the foregoing discourse about crises, there is, I confess, much of paradox; and it was unwillingly enough that I made an excursion, or in-road into a subject that has been looked upon as the physician's peculiar province. And you may remember, that, not far from the beginning of this little book, I told you that I was willing to decline meddling with other than inanimate bodies; living ones being, as of a less simple sort, so of a more intricate speculation: which reflection will, I hope, excuse me to you, if you find, that my proposed brevity, or the difficulty of the subject, has had any great influence on what I write, about health, diseases, and crises. And, as for the sons of *Æsculapius*, it may be represented to them, in my favour, that, besides that I have treated of sickness and crises, rather as a physiologist than a physician, I could not leave them unconsidered, without being thought, if not to betray, at least to be wanting to the cause I was to plead for.

If it should be disliked that I make the phænomena of the merely corporeal part of the world, under which I comprise the bodies of animals, though not the rational souls of men, to be too generally referred to laws mechanical; I hope you will remember, for me, several things dispersed in this treatise, that may, when laid together, afford a sufficient answer to this surmise; and particularly, that almost all the modern philosophers, and among them divers eminent divines, scruple not to forsake the spread opinion, that the celestial orbs were moved and guided by intelligences; and to explicate, by physical causes, the eclipses of the sun and moon, the production or apparition and phænomena of comets, and other things, that the Romans, as well as other heathens, both antient and modern, have ascribed to the immediate agency of divine causes. This allows me to observe to you, that, since these modern naturalists and divines are wont to explicate the phænomena of the vast celestial bodies, by their local motions, and the consequences of them, they do, as well as I, endeavour to account for what happens in the incomparably greatest part of the universe, by physico-mechanical principles and laws. And, even in the terrestrial part of the world, which we men inhabit, most of the moderns, that have freed themselves from the prejudices of the schools, do not stick to give statical, hydrostatical, and other mechanical explications of the ascension of water in pumps, the detention of it in watering-pots, whose upper orifices are closed, and of other various phænomena, which were formerly unanimously ascribed to nature's wonderful providence, expressed in her care to hinder a vacuum.

BUT perhaps you will think it fitter for me to provide against their censure, who will dislike what I have written about crises, not because I have ascribed too much to merely physical causes, but (on the contrary) because I do not strictly confine myself to them: for I doubt, that if you should shew these papers to some of your friends, that affect to be strict naturalists, they will think it strange, that in one of the clauses in the foregoing discourse about crises (I mean that to which this mark [N. B.] is prefixed) I admit, that their events may sometimes be varied by some peculiar interposition of God. But yet I own to you, that the clause, it is like they would take exceptions at, did not unawares slip from my pen; for it is my settled opinion, that divine providence is often, at least, conversant in a peculiar manner about the actions of men, and the things that happen to them, or have a necessary connexion with the one or the other, or both. And though I think it probable, that, in the conduct of that far greatest part of the universe which is merely corporeal, the wise Author of it does seldom manifestly procure a recession from the settled course of the universe, and especially from the most catholic laws of motion; yet, where men, who are crea-

tures, that he is pleased to endow with free wills, (at least in reference to things not spiritual) are nearly and highly concerned; I think he has, not only sometimes by those signal and manifest interpositions we call miracles, acted by a supernatural way, but, as the sovereign Lord and Governor of the world, doth divers times (and perhaps oftener than mere philosophers imagine) give, by the intervention of rational minds, as well united, as not united, to human bodies, divers such determinations to the motion of parts in those bodies, and of others which may be affected by them, as by laws merely mechanical those parts of matter would not have had: by which motions, so determined, either salutary or fatal crises, and many other things conducive to the welfare or detriment of men, are produced.

The fifth
command-
ment, in
Exod. xx.
Psaln v. 6.
Psaln lv.
23.
2 Kings i.
16.
Is. xxxviii.

James x.
25.

1 Cor. xi.
30.

* A dis-
course re-
lating to
miracles.

THE interpositions of divine Providence, in cases of life and death, might be easily shewn to Christians out of divers passages of scripture, which expressly proposed long life as a reward to obedient children, and to other righteous persons among the *Jews*, and threatens *bloody and deceitful men*, that they *shall not live out half their days*; and which relates, that a king of *Israel* had his disease made mortal by his impious recourse to the false god of *Eckron*, and that, upon *Hezekiah's* prayers and tears, God was pleased to add fifteen years to his life, and grant a special benediction to an outward medicine applied to his threatening sore. To which passages divers might be added out of the new testament also, and especially that of *St. James*, who exhorts the sick to seek for recovery by prayer; and that of *St. Paul*, where, speaking to the *Corinthians* of the unworthy receivers of the eucharist, he tells them, that *For that cause divers were become sick and weak among them, and many also died*. But though the nature of this discourse dissuades me from employing the authority of scripture, yet it allows me to observe, (what is considerable on this occasion) that natural theology and right reason comport very well with our proposed doctrine: for, as I lately intimated, and do more fully shew, in another paper *, God has left to the will of man the direction of many local motions in the parts of his own body, and thereby of some others; though the mechanical laws, on which the ordinary course of things mainly depends, do not only regulate the motions of bodies, but the determinations too, and since man himself is vouchsafed a power to alter, in several cases, the usual course of things, it should not seem incredible, that the latent interposition of men, or perhaps angels, or other causes unthought of by us, should sometimes be employed to the like purposes by God, who is not only the all-wise Maker, but the absolute and yet most just and benign Rector of the universe and of men.

To conclude this excursion, which I hope will not appear useless, that has been occasioned by the discourse of crises, I think it becomes a Christian philosopher to admit, in general, that God doth sometimes, in a peculiar though hidden way, interpose in the ordinary phaenomena and events of crises; but yet that this is done so seldom, at least in a way that we can certainly discern, that we are not hastily to have recourse to an extraordinary providence, and much less to the strange care and skill of that questioned being called nature, in this or that particular case, though perhaps unexpected, if it may be probably accounted for by mechanical laws, and the ordinary course of things.

AND here, though in a place less proper than I might have chosen if I had timely remembered, I shall, both in reference to the extraordinary accidents that sometimes happen in crises, and more generally to the seemingly irregular phaenomena of the universe, venture to offer you a notion that perhaps you will not dislike. I think then, that, when we consider the world, and the physical changes that happen in it, with reference to the Divine Wisdom and Providence, the arguments for the affirmative ought, in their kind, to have more force than those for the negative. For it seems

more

more allowable to argue a providence, from the exquisite structure and symmetry of the mundane bodies, and the apt subordination and train of causes, than to infer from some physical anomalies, that things are not framed and administered by a wise author and rector: for the characters and impressions of wisdom, that are conspicuous in the curious fabrick and orderly train of things, can, with no probability, be referred to blind chance, but must be to a most intelligent and designing agent. Whereas on the other hand, besides that the anomalies, we speak of, are incomparably fewer than those things, which are regular, and are produced in an orderly way; besides this, I say, the divine Maker of the universe, being a most free agent, and having an intellect infinitely superior to ours, may, in the production of seemingly irregular phenomena, have ends unknown to us, which even the anomalies may be very fit to compass.

Thus, when a man, not versed in the mathematicks, looks upon a curious geographical globe, though as soon as he perceives, that the differing bignesses, and particular confines of kingdoms and provinces, and the apt situations, true distances and bearings of the cities and towns he knows by sight or fame, be rightly set down, he cannot but conclude, from these impresses of art or skill, that this was the work of a designing artificer: but though he also sees on the same globe several circles, as the tropicks, the zodiack, the meridians, &c. if he be a sober man, he will not think, that these were made by chance only, because he knows not the reasons or uses of them, or because some of the lines, as those curve lines the seamen call rhumbs, are not, like the other, circular, but do oddly, and, with a seeming irregularity, intersect them; but will rather think, that the artist, that had knowledge enough to represent the globe of the earth and waters, in a body not two feet in diameter, had also skill enough to draw those lines, with some design worthy of the same skill, though not obvious to those, that are unacquainted with his art.

I DID not incogitantly speak of irregularities, as if they might sometimes be but seeming ones: for I think it very possible, that an artificer of so vast a comprehension, and so piercing a sight, as is the Maker of the world, might, in this great automaton of his, have so ordered things, that divers of them may appear to us, and, as it were, break out abruptly and unexpectedly, and at great distances of time or place from one another, and on such accounts be thought irregular; which yet really have, both in his pre-ordination, and in the connection of their genuine causes, a reference, that would, if we discerned it, keep us from imputing it either to chance, or to nature's aberrations. To illustrate this a little, let us consider, that if, when the Jesuits, that first came into *China*, presented a curious striking watch to the king, he, that looked to it, had wound up the alarum so as to strike a little after one; if, I say, this had been done, and that these Chineses, that looked upon it as a living creature, or some European animal, would think, that when the index, pointing at two of the clock, likewise struck the same hour, and so three, four, and on-ward, they would judge, that these noises were regularly produced, because they (at equal intervals of time) heard them, and whensoever the index pointed at an hour, and never but then; but when the alarum came unexpectedly to make a loud, confused, and more lasting noise, they could scarce avoid thinking that the animal was sick, or exceedingly disordered: and yet the alarming noise, did as properly flow from the structure of the little engine, and was as much designed by the manager of it, as those sounds of the clock, that appeared manifestly regular.

S E C T. VII.

I PROCEED now to the sixth and difficultest part of my task, which is to shew, that the most general and current effata and axioms concerning nature, that are wont to be employed in the writings of philosophers, may have a fair account given of them, agreeably to the doctrine I have hitherto proposed, though these axioms do some of them suppose, and others seem strongly to support, the received notion of nature.

To clear the way for the ensuing explications, I must desire you to recall to mind the two cautions I have formerly offered you (in the fifth section) wherewith I would have the common doctrine, about the ends or designs of nature, to be understood or limited; and therefore I shall not here repeat, what I there said, but only add in two words, that if those, and some few other such things, had been observed and duly considered, they might perhaps have prevented much of the obscurity, and some of the errors, that relate to the notion of nature.

I HOPE you have not forgot, that the design of this paper was to examine the vulgar notion of nature, not to establish a new one of my own. And indeed the ambiguity of the word is so great, (as hath in the second section been made appear) and it is, even by learned men, frequently employed to signify such different things; that, without enumerating and distinguishing its various acceptions, it were very unsafe to venture at giving a definition of it, and perhaps it were very impossible to give any, that would not be liable to censure. I shall not therefore here presume to define a thing, of which I have not found a stated and settled notion so far agreed on amongst men, but that I was obliged, out of *Aristotle* and others, to compile, in the fourth section, a collective representation of the vulgarly received idea, or notion of nature; and afterwards to draw up, as well as I could, instead of an accurate definition, tolerable descriptions of what, on most occasions, may be intelligibly meant by it. Wherefore, desiring and presuming, that you will retain in your mind, and, as occasion shall require, apply, in the following part of this essay, the things already delivered in the fourth section, I will not trouble you with the repetition of them.

BUT before I descend to treat of the particular effata or sentences, that are received concerning nature's actings, it may not be improper, nor unuseful, to try, if we can clear the way, by considering in what sense nature may, or may not, be said to act at all. For, for aught I can clearly discern, whatsoever is performed in the merely material world, is really done by particular bodies, acting according to the laws of motion, rest, &c. that are settled and maintained by God among things corporeal; in which hypothesis nature seems rather a notional thing, than a true physical, and distinct or separate efficient; such as would be, in case *Aristotle's* doctrine were true, one of those intelligences that he presumed to be the movers of the celestial orbs. But men do oftentimes express themselves so very ambiguously or intricately, when they say, that nature does this and that, or, that she acts thus and thus, that it is scarce (if at all) possible to translate their expressions into any forms of speech, adequate to the original, and yet intelligible: for which reason, though I have in the section said something to the same purpose with what I am now to propose, yet the difficulty and weight of the subject makes me think it may be expedient, if not necessary, in this place somewhat more fully to declare what men do, or should mean, when they speak of nature's acting, or of a thing's being natu-

turally done or performed, by giving their words and phrases sometimes one interpretation, and sometimes another.

I. SOMETIMES, when it is said that nature does this or that, it is less proper to say, that it is done by nature, than that it is done according to nature: so that nature is not to be looked on as a distinct or separate agent, but as a rule, or rather a system of rules, according to which those agents, and the bodies they work on, are, by the great Author of things, determined to act and suffer.

THUS, when water is raised in a sucking-pump, it is said that nature makes the water ascend after the sucker, to prevent a vacuum; though in reality this ascension is made, not by such a separate agent as nature is fancied to be, but by the pressure of the atmosphere acting upon the water, according to statical rules, or the laws or the æquilibrium of liquors, settled by God among fluids, whether visible or pneumatical. So, when the strict Peripatetics tell us, that all the visible celestial orbs being, by a motion that they call violent, hurried about the earth every four-and-twenty hours, from east to west, each of the planetary orbs has a natural motion, that is quite contrary, tending from the west to the east; if they will speak congruously to their master's doctrine, they must use the term natural in the sense our observation gives it; since *Aristotle* will have the celestial orbs to be moved by external or separate agents, namely, spiritual intelligences. Our observation may be also illustrated by other forms of speech that are in use; as when it is said, that the law takes care of infants and lunatics, that their indiscreet actions or omissions should not damnify their inheritances; and that the law hangs men for murder, but only burns them in the hand for some lesser faults; of which phrases the meaning is, that magistrates and other ministers of justice, acting according to the law of the land, do the things mentioned. And it tends yet more directly to our purpose to take notice, that it is common to ascribe to art those things that are really performed by artificers, according to the prescriptions of the art; as when it is said that geometry (as the name imports) measures land, astrology foretels changes of weather, and other future accidents, architecture makes buildings, and chymistry prepares medicines.

II. SOMETIMES, when divers things, such as the growth of trees, the maturation of fruits, &c. are said to be performed by the course of nature, the meaning ought to be, that such things will be brought to pass by their proper and immediate causes, according to the wonted manner and series or order of their actings. Thus it is said, that by the course of nature the summer days are longer than those of the winter; that, when the moon is in opposition to the sun, (that is in the full moon) that part of her body, which respects the earth, is more enlightened than at the new moon, or at either of the quadratures; and lastly, that, when she enters more or less into the conical shadow of the earth, she suffers a total or a partial eclipse: and yet these, and other illustrious phenomena, may be clearly explicated, without recourse to any such being as the Aristotelians nature, barely by considering the situations and wonted motions of the sun or earth, and the moon, with reference to each other, and to the terrestrial globe.

AND here it may not be amiss to take notice, that we may sometimes usefully distinguish between the laws of nature, more properly so called, and the custom of nature, or, if you please, between the fundamental and general constitutions among bodily things, and the municipal laws (if I may so call them) that belong to this or that particular sort of bodies. As, to resume and somewhat vary our instance drawn from water, when this falls to the ground, it may be said to do so by virtue of the custom of nature, it being almost constantly usual for that liquor to tend downwards, and actually to fall down, if it be not hindered: but when water ascends by

suction in a pump, or other instrument, that motion, being contrary to that which is wonted, is made in virtue of a more catholic law of nature, by which it is provided, that a greater pressure, which in our case the water suffers from the weight of the incumbent air, should surmount a lesser, such as is here the gravity of the water, that ascends in the pump or pipe.

THE two foregoing observations may be farther illustrated, by considering in what sense men speak of things which they call preter-natural, or else contrary to nature: for divers if not most of their expressions of this kind argue, that nature is in them taken for the particular and subordinate (or as it were the municipal) laws established among bodies. Thus water, when it is intensely hot, is said to be in a preter-natural state, because it is in one that is not usual to it, and, men think, doth not regularly belong to it; though the fire or sun, that thus agitates it, and puts it into this state, is confessed to be a natural agent, and is not thought to act otherwise than according to nature. Thus when a spring, forcibly bent, is conceived to be in a state contrary to its nature, as is argued from its incessant endeavour to remove the compressing body; this state, whether preter-natural or contrary to nature, should be thought such but in reference to the springy body: for otherwise it is as agreeable to the grand laws, that obtain among things corporeal, that such a spring should remain bent by the degree of force that actually keeps it so, as that it should display itself in spight of a less or incompetent degree of force. And, to omit the six non-natural things so much spoken of by physicians, I must here take notice, that though a disease be generally reckoned as a preter-natural thing, or, as others carry the notion farther, a state contrary to nature; yet that must be understood only with reference to what customarily happens to a human body: since excessively cold winds, and immoderate rains, and sultry air, and other usual causes of diseases, are as natural agents, and act as agreeably to the catholic laws of the universe, when they produce diseases, as when they condense the clouds into rain or snow, blow ships into their harbour, make rivers overflow, ripen corn and fruit, and do such other things, whether they be hurtful or beneficial to men. And, upon a like account, when monsters are said to be preter-natural things, the expression is to be understood with regard to that particular species of bodies from which the monster does enormously deviate, though the causes, that produce that deviation, act but according to the general laws whereby things corporeal are guided.

III. I DOUBT whether I should add as a third remark, or as somewhat that is referrible to one or both of the two foregoing, that sometimes, when it is said that nature performs this or that thing, we are not to conceive that this thing is an effect really produced by other than by proper physical causes or agents; but, in such expressions, we are rather to look upon nature, either as a relative thing, or as a term employed to denote a notional thing, with reference whereunto physical causes are considered as acting after some peculiar manner, whereby we may distinguish their operations from those that are produced by other agents, or perhaps by the same, considered as acting in another way. This, I think, may be illustrated by some other received expressions, or forms of speech. As, when many of the antient and some of the modern philosophers have said, that things are brought fatally to pass; they did not mean, that fate was a distinct and separate agent, but only that the physical causes performed the effect, as in their actings they had a necessary dependance upon one another, or an inviolable connexion that linked them together. And, on the other side, when men say, as they too frequently do, that fortune or chance, *ἡ τύχη* or *τὸ ἀνόρατον* (for Aristotle and his followers distinguish them, ascribing to the former what unexpectedly happens to deliberating or designing, and to the latter what hap-

pens

*Differunt
autem for-
tuna et ca-
sus, quia
casus latius
patet. Quod
enim a for-
tuna est,
casu est;
hoc autem
non omne
est a for-
tuna.
Arist. Au-
scult. l. ii.
c. 4.*

pens to inanimate or undesigning beings) has done this or that; considerate philosophers do not look upon fortune or chance as a true and distinct physical cause, but as a notional thing, which denotes that the proper agents produced the effect without an intention to do so, (as I have more fully declared in the fourth section.)

ONE may, for aught I know, without impertinence, refer to this our third observation, that many things are wont to be attributed to time; as, when we say, that time ripens some fruits, that are too early gathered; that it makes many things moulder and decay, (*tempus edax rerum*;) that it is the mother of truth; that it produces great alterations, both in the affairs of men and in their dispositions and their bodies: to omit many other vulgar expressions, which represent time as the cause of several things, whereof really it is but an adjunct or a concomitant of the effects, (however coincident with the successive parts of time, and so some way related to it) being indeed produced by other agents, that are their true and proper efficient.

SOMETIMES likewise, when it is said that nature does this or that, we ought not to suppose that the effect is produced by a distinct or separate being; but, on such occasions, the word nature is to be conceived to signify a complex or convention of all the essential properties, or necessary qualities, that belong to a body of that species whereof the real agent is, or to more bodies respectively, if more concur to the production of the effect. To this sense we are to expound many of those forms of speech, that are wont to be employed, when physicians, or others, speak of what nature does in reference to diseases, or the cure of them. And, to give a right sense to such expressions, I consider nature, not as a principal and distinct agent, but a kind of compounded accident, that is (as it were) made up of, or results from, the divers properties and qualities that belong to the true agents. And, that the name of a compounded accident may not be startled at, I shall, to explain what I mean by it, observe, that, as there are some qualities or accidents, that, at least in comparison of others, may be called simple, as roundness, straightness, heat, gravity, &c. so there are others that may be conceived as compounded, or made up of several qualities united in one subject: as, in divers pigments, greenness is made up of blue and yellow, exquisitely mixed; beauty is made up of fit colours, taking features, just stature, fine shape, graceful motions, and some other accidents of the human body and its parts. And of this sort of compounded accidents, I am apt to think, there are far more than at the first mention of them one would imagine. And to this kind of beings, the expressions, that naturists do on divers occasions employ, incline me to think, that, what is called nature has a great affinity, at least in reference to those occasions. On which supposition one may conceive, that, as when it is said, that health makes a man eat well, digest well, sleep well, &c. considering men do not look upon health as a distinct and separate cause of these effects; but as what we lately called a compounded accident, that is, a complex of all the real and genuine causes of good appetite, digestion, sleep, &c. inasmuch that health is not so properly the cause of these as their effect or result: so in divers things, that nature is said to do, we need conceive no more than that the effects are produced by physical bodies and qualities, or other proper causes; which, when we consider as conspiring, or rather concurring, to produce the same effect, by a compendious term we call nature.

By these and the like ways of interpretation I thought fit to try, whether I could give an intelligible and commodious sense to divers of the maxims or sentences, and other forms of speech, that are employed by those that, on many occasions, in differing expressions, say that nature does this or that, and acts thus and thus. But I confess, that to clear all those ambiguous and unskillfully framed axioms and phrases, I found to be so intricate and difficult a task, that, for want of time, and perhaps too of patience,

tience, I grew weary before I had prosecuted it to the utmost: for which reason, though it is not improbable that some light may be given in this dark subject by what I have been now saying, (as immature and unfinished as it is) especially if it be reflected on in conjunction with what hath been formerly delivered (in the fourth section) about nature, general and particular; yet I shall, at present, make but very little use of the things that have been now said, in expounding the axioms I am particularly to consider in this seventh section; hoping that I may, by the help of other mediums, dispatch my work without them. And, to do it the more easily, I shall, without tying myself to the order wherein they are marshalled after the beginning of the fourth section, treat of them in the order wherein I think their explications may give most light to one another, or in that wherein the papers that belonged to them were retrieved.

THE first of the received axioms I shall consider is, that which pronounces, that *omnis natura est conservatrix sui*; where, by the word nature, I suppose they understand a natural body, for otherwise I know not what they meant. Now this axiom easily admits of a twofold interpretation: for either it may signify no more than, that no one body does tend to its own destruction, that is, to destroy itself; or else, that in every body there is a principle called nature, upon whose score the body is vigilant and industrious to preserve its natural state, and to defend itself from the violence and attempts of all other bodies that oppugn it, or endeavour to destroy or harm it.

IN the former of these two senses the axiom may be admitted, without any prejudice to our doctrine: for since, according to our hypothesis, inanimate bodies can have neither appetites, nor hatreds, nor designs, which are all of them affections, not of brute matter but of intelligent beings; I, that think inanimate bodies have no appetites at all, may easily grant, that they have not any to destroy themselves.

BUT, according to the other sense of the proposed axiom, it will import, that every body has, within itself, a principle, whereby it does desire, and with all its power endeavour, to compass its own preservation; and both to do those things that tend thereunto, and oppose all endeavours that outward agents, or internal distempers, may use in order to the destruction of it.

AND as this is the most vulgar sense of this axiom, so it is chiefly in this sense that I am concerned to examine it.

I CONCEIVE then, that the most wise Creator of things did at first so frame the world, and settle such laws of motion between the bodies that, as parts, compose it, that, by the assistance of his general concurrence, the parts of the universe, especially those that are the greater and the more noble, are lodged in such places, and furnished with such powers, that, by the help of his general providence, they may have their beings continued and maintained as long, and as far forth, as the course He thought fit to establish, among other things corporeal, requires.

UPON this supposition, which is but a reasonable one, there will appear no necessity to have any recourse, for the preservation of particular bodies, to such an internal appetite and inbred knowledge in each of them as our adversaries presume; since, by virtue of the original frame of things, and established laws of motion, bodies are necessarily determined to act on such occasions after the manner they would do if they had really an aim at self-preservation: as you see, that if a blown bladder be compressed, and thereby the included air be forced out of its wonted dimensions and figure, it will incessantly endeavour to throw off and repel that which offers violence unto it, and first displace that part of the compressing body that it finds weakest; though in all this there be no appetite in the air, (as I elsewhere shew) no more than in the bladder, to that particular figure, to maintain itself in which it seems so concerned.

THUS,

THUS, it is all one to a lump of dough, whether you make it into a round loaf, or a long roll, or a flat cake, or give it any other form; for whatever figure your hands or your instruments leave in it, that it will retain, without having any appetite to return to that which it last had. So it is all one to a piece of wax, whether your seal imprints on it the figure of a wolf or that of a lamb. And, for brevity's sake, to pass by the instances that might be drawn from what happens to wood, and marble, and metals, as they are differently shaped by the statuary's art and tools; I will only observe, that the mariner's needle, before it is excited, may have no particular propensity to have respect to one part of heaven more than another; but, when it has been duly touched upon a loadstone, the flower de-luce will be determined to regard the North, and the opposite extremity the South: so that if the lilly be drawn aside, towards the East or towards the West, as soon as the force that detained it is removed, it will return to its former position, and never rest until it regard the North. But in spite of this seeming affection of the lilly to that point of the horizon, yet, if the needle be duly touched upon the contrary pole of the same or another vigorous loadstone, the lilly will presently forget its former inclination, and regard the southern part of heaven; to which position it will as it were spontaneously return, having been forced aside towards the East or towards the West, if it be again left to its liberty. So that though it formerly seemed so much to affect one point of heaven, yet it may, in a trice, be brought to have a strong propensity for the opposite: the lilly having indeed no inclination for one point of heaven more than another, but resting in that position to which it was last determined by the prevalence of magnetical effluvia. And this example may serve to illustrate and confirm what we have been lately saying in general.

II. ANOTHER received axiom concerning nature is, that she never fails or misses of her ends, *Natura sine suo nunquam excidit*. This is a proposition whose ambiguity makes it uneasy for me to deliver my sense of it; but yet, to say somewhat, if by nature we here understand that being that the schoolmen style *natura naturans*, I grant, or rather assert, that nature never misseth its end. For the omniscient and almighty Author of things having once framed the world, and established in it the laws of motion, which he constantly maintains, there can no irregularity or anomaly happen, especially among the greater mundane bodies, that he did not from the beginning foresee and think fit to permit, since they are but genuine consequences of that order of things that at the beginning he most wisely instituted: as I have formerly declared in instances of the eclipses of the sun and moon; to which I could add others, as the inundations of *Nilus*, so necessary to the health and plenty of *Egypt*. And though, on some special occasions, this instituted order, either seemingly or really, has been violated, as when the sun is said to have stood still in the days of *Joshua*, and the *Red-Sea* to have divided itself to give free passage to the *Israelites* led by *Moses*; yet these things having been rarely done, for weighty ends and purposes, by the peculiar intervention of the First Cause, either guiding or over-ruling the propensities and motions of secondary agents; it cannot be said that God is frustrated of his ends by these designed though seeming exorbitances by which he most wisely and effectually accomplishes them. But if by nature be meant such a subordinate principle as men are wont to understand by that name, I doubt the axiom is in many cases false; for though it be true, as I have often said, that the material world is so constituted, that, for the most part, things are brought to pass by corporeal agents as regularly as if they designed the effects they produce, yet there are several cases wherein things happen quite otherwise.

THUS it is confessed, that, when a woman is with child, the aim of nature is to produce a perfect or genuine human foetus; and yet we often see that nature, widely
missing

missing her mark, instead of that, produces a monster: and of this we have such frequent instances, that whole volumes have been published, to recount and describe these gross and deformed aberrations of nature. We many times see, (and I have formerly noted) that in fevers, and other acute diseases, she makes critical attempts upon improper days, and in these unseasonable attempts does not only for the most part miss of her end, which is to cure the patient, but often brings him to a far worse condition than he was in before she used those miscarrying endeavours. To this may be referred the cheats men put upon nature; as when, by grafting, the sap, that nature raises with intention to feed the fruit of a white thorn, (for instance) is by the gardener brought to nourish a fruit of quite another kind. So, when malsters make barley to sprout, that germination, whereby nature intended to produce stalks and ears, is perverted to a far differing purpose, and she deluded. And now, to annex some arguments *ad hominem*, we are told, that nature makes every agent aim at assimilating the patient to itself, and that upon this account the fire aims at converting wood, and the other bodies it works on, into fire. But, if this be so, nature must often miss of her end in chymical furnaces, where the flame does never turn the bricks, that it makes red-hot, into fire; nor the crucibles, nor the cupels, nor yet the gold and silver, that it thoroughly pervades, and brings to be of a colour, the same, or very near the same, with its own, and keeps in a very intense degree of heat, and in actual fusion. And even when fire acts upon wood, there is but one part of it turned into fire, since, to say nothing of the soot and concreted smoke, the ashes remain fixed and incombustible. And so, to add another instance *ad hominem*, when we are told, that nature makes water ascend in sucking-pumps, *ob fugam vacui*, she must needs (as I formerly noted to another purpose) miss of her aim, when the pump exceeds five and thirty, or forty, feet, in height; for then, though you pump never so much, and withdraw the air from the upper part of the engine, the water will not ascend to the top, and consequently will leave a cavity, for whose replenishing she was supposed to have raised that liquor two or three and thirty feet.

III. ANOTHER of the celebrated axioms concerning nature is, that she always acts by the shortest or most compendious ways: *Natura semper agit per vias brevissimas*. But this rule, as well as divers others, does, I think, require to be somewhat explained and limited, before it be admitted. For it is true, that, as I have frequently occasion to inculcate, the omniscient Author of the universe has so framed it, that most of the parts of it act as regularly, in order to the ends of it, as if they did it with design. But, since inanimate bodies, at least, have no knowledge, it cannot reasonably be supposed, that they moderate and vary their own actions, according to the exigency of particular circumstances, wherewith they must of necessity be unacquainted; and therefore it were strange, if there were not divers occurrences, wherein they are determined to act by other than the shortest ways that lead to particular ends, if those other ways be more congruous to the general laws or customs established among things corporeal. This I prove by instances taken from gravity itself, which is, perhaps, that quality which of all others is most probably referred to an inbred power and propension: for it is true, that, if a stone, or another heavy body, be let fall into the free air, it will take its course directly towards the centre of the earth; and, if it meet with an inclining plane, which puts it out of its way, it will not for all that lose its tendency towards the centre, but run along that plane, by which means its tendency downwards is prosecuted, though not, as before, in a perpendicular line, yet in the shortest way it is permitted to take. These obvious phenomena, I confess, agree very well with the vulgar axiom, and possibly were the chief things that induced men to frame it. But now let us suppose, that a small

bullet of marble or steel, after having for a pretty space fallen through the air, lights upon a pavement of marble, or some such hard stone, that lies, as floors are wont to do, horizontal; in this case experience shews, (as was formerly noted on another occasion) that the falling stone will rebound to a considerable height, (in proportion to that it fell from) and falling down again rebound the second time, though not so high as before; and, in short, rebound several times before, by settling upon the floor, it approaches as near as is permitted it to the centre of heavy bodies: whereas, if nature did in all cases act by the most compendious ways, this bullet ought not to rebound at all; but, as soon as it found, by the hardness of the floor, it could descend no lower, it ought to have rested there, as in the nearest place it could obtain to the centre of the earth, whence every rebound must necessarily remove it to a greater distance. And so likewise, when a pendulum, or bullet fastened to the end of a string, is so held that the string is (*præter propter*) parallel to the horizon, if it be thence let fall, it will not stop at the perpendicular line, or line of direction, which is supposed to reach from the nail or other prop through the centre of the bullet to the centre of the earth, but will pass beyond it, and vibrate or swing to and fro, until it have passed again and again the line of direction, for a great while before the bullet come to settle in it, though, whenever it removes out of it, towards either hand, it must really ascend or move upwards, and so go further off from the centre of the earth, to which, it is pretended, its innate propensity determines it to approach as much and as soon as is possible. But this instance having been formerly touched upon, I shall now observe, to the same purpose, that having taken a good sea-compass, [and the experiment succeeded with a naked, yet nicely poised, needle] and suffered the magnetic needle to rest north and south; if I held the proper pole of a good loadstone at a convenient distance on the right or left hand of the lilly, this would be drawn aside from the north point towards the east or west, as I pleased; and then, the loadstone being removed quite away, the lilly of the needle would indeed return northward, but would not stop in the magnetic meridian, but pass on divers degrees beyond it, and would thence return without stopping at the meridian line; and so would, by its vibrations, describe many arches still shorter and shorter, until at length it came to settle on it, and recover that position which, if nature always acted by the most compendious ways, it should have rested at the first time that by the removal of the loadstone he had regained it. But the truth is, that at least inanimate bodies, acting without knowledge or design of their own, cannot stop or moderate their own action, but must necessarily move as they are determined by the catholic laws of motion, according to which, in one case, the impetus, that the bullet acquires by falling, is more powerful to carry it on beyond the line of direction, than the action of the causes of gravity is to stop it as soon as it comes to the nearest place they can give it to the center of the earth. And something like this happens in levity, as well as gravity; for if you take an oblong and conveniently shaped piece of light wood, as fir or deal, and, having thrust or sunk it to the bottom of a somewhat deep stagnant water, give it leave to ascend; it will not only regain the surface of the water, where, by the laws of gravity it ought to rest, and did rest before it was forced down, but it will pass far beyond that surface, and in part as it were shoot itself up into the incumbent air, and then fall down again, and rise a second time, and perhaps much oftner, and fall again, before it come to settle in its due place, in which it is in an æquilibrium with the water, that endeavours to press it upwards.

ANOTHER of the sentences, that are generally received concerning nature, is, that she always does what is best to be done: *Natura semper quod optimum est facit*. But of this it will not be safe for me to deliver my opinion, until I have endeavoured

Natura semper id facit quod est opti-

num co-
rum quæ
feri pos-
sunt. *Arist.*
de Cælo.
l. ii. c. 4.
See also
Arist. de
Gen. l. ii.
c. 10. § 22.

to remove the ambiguity of the words; for they easily admit of two different senses; since they may signify, that nature in the whole universe does always that which is best for the conservation of it in its present state; or that, in reference to each body in particular, nature does still what is best, that is, what most conduces to the preservation and welfare of that body. If the first of these senses be pitched upon, the axiom will be less liable to exception: but then, I fear, it will be difficult to be positively made out by such instances as will prove, that nature acts otherwise than necessarily according to laws mechanical; and therefore, until I meet with such proofs, I shall proceed to the other sense that may be given our axiom, which, though it be the most usual, yet, I confess, I cannot admit, without it be both explained and limited. I readily grant, that the all-wise Author of things corporeal has so framed the world, that most things happen in it as if the particular bodies that compose it were watchful both for their own welfare and that of the universe. But I think withal, that particular bodies, at least those that are inanimate, acting without either knowledge or design, their actions do not tend to what is best for them in their private capacities, any further than will comport with the general laws of motion, and the important customs established among things corporeal: so that, to conform to these, divers things are done, that are neither the best, nor so much as good, in reference to the welfare of particular bodies.

THESE sentiments I am induced to take up, not only by the more speculative considerations that have been formerly discoursed of, and therefore shall not here be repeated, but by daily observations and obvious experience.

WE see oftentimes that fruit-trees, especially when they grow old, will for one season be so overcharged with fruit, that soon after they decay and die; and even whilst they flourish, the excessive weight of the too numerous fruits does not seldom break off the branches they grow upon, and thereby both hinders the maturity of the fruit, and hastens the death of the tree: whereas this fatal profuseness would have been prevented, if a wise nature, harboured in the plant, did, as is presumed, solicitously intend his welfare.

WE see also in divers diseases, and in the unseasonable and hurtful crises of fevers, how far what men call nature oftentimes is from doing that which is best for the sick man's preservation. And indeed (as hath been formerly noted on another occasion) in many diseases, as bleedings, convulsions, choleras, &c. a great part of the physician's work is to appease the fury and to correct the errors of nature, which, being as it were transported with a blind and impetuous passion, unseasonably produces those dangerous disorders in the body, that, if she were wise, and watchful of its welfare, she would have been as careful to prevent, as the physicians to remedy them.

ADD to all this, that if nature be so provident, and watchful for the good of men and other animals, and of that part of the world wherein they live; how comes it to pass, that from time to time she destroys such multitudes of men and beasts, by earthquakes, pestilences, famine, and other anomalies? And how comes it so often to pass in teeming women, that, perhaps by a fright, or a longing desire, or the bare sight of any outward object, nature suffers herself to be so disordered, and is brought to forget her plastic skill so much, as, instead of well-formed infants, to produce hideous monsters, and those oftentimes so mishapen and ill-contrived, that not only themselves are unfit to live one day, or perhaps one hour, but cannot come into the world without killing the mother that bare them. These and such other anomalies, though (as I have elsewhere shewn) they be not repugnant to the catholic laws of the universe, and may be accounted for in the doctrine of God's general providence;

yet they would seem to be aberrations incongruous enough to the idea the schools give of nature, as of a being that, according to the axiom hitherto considered, does always that which is best. But it is time that we pass from that to the examen of another.

THOUGH I have had occasion to treat of vacuum in the fifth section, yet I must also say something about it in this, because I there considered it but as it is employed by the Peripatetics and others to shew the necessity of the principle they call nature. But now I am to treat of it, not so much as an argument to be confuted, as on the score of its belonging to a very plausible axiom to be considered; although I fear that, by reason of the identity of the subject, (though considered in the fifth section and here to differing purposes) I shall scarce avoid saying something or other co-incident with what has been said already.

V. THE word vacuum being ambiguous, and used in differing senses, I think it requisite, before I declare my opinion about the generally received axiom of the schools, that *natura vacuum borret*, (or, as some express it, *abborret à vacuo*) to premise the chief acceptions in which I have observed the term vacuum to be made use of: for it has sometimes a vulgar, and sometimes a philosophical or strict, signification. In common speech, to be empty, usually denotes, not to be devoid of all body whatsoever, but of that body that men suppose should be in the thing spoken of, or of that which it was framed or designed to contain; as when men say, that a purse is empty, if there be no money in it; or a bladder, when the air is squeezed out; or a barrel, when either it has not been yet filled with liquor, or has had the wine or other drink drawn out of it. The word vacuum is also taken in another sense by philosophers, that speak strictly, when they mean by it a space within the world (for I here meddle not with the imaginary spaces of the schoolmen, beyond the bounds of the universe) wherein there is not contained any body whatsoever. This distinction being premised, I shall inform you, that taking the word vacuum in the strict sense, though many, and, among them, some of my best friends, pressed me to a declaration of my sense about that famous controversy, *an detur vacuum*, because they were pleased to suppose I had made more trials than others had done about it; yet I have refused to declare myself, either *pro* or *contra*, in that dispute: since the decision of the question seems to depend upon the stating of the true notion of a body, whose essence the Cartesians affirm, and most other philosophers deny, to consist only in extension, according to the three dimensions, length, breadth, and depth or thickness; for, if Mr. *Des Cartes's* notion be admitted, it will be irrational to admit a vacuum, since any space, that is pretended to be empty, must be acknowledged to have the three dimensions, and consequently all that is necessary to essentiate a body: and all the experiments, that can be made with quicksilver, or the machina Boyliana (as they call it), or other instruments contrived for the like uses, will be eluded by the Cartesians, who will say, that the space deserted by the mercury, or the air, is not empty, since it has length, breadth, and depth, but is filled by their *materia subtilis*, that is fine enough to get freely in and out of the pores of the glasses, as the effluvia of the loadstone can do. But though, for these and other reasons, I still forbear (as I lately said I have formerly done) to declare either way in the controversy about vacuum, yet I shall not stick to acknowledge, that I do not acquiesce in the axiom of the schools, that nature abhors a vacuum.

For, first, I consider, that the chief, if not the only, reason, that moves the generality of philosophers to believe that nature abhors a vacuum, is, that in some cases, as the ascension of water in sucking-pumps, &c. they observe that there is an unusual endeavour, and perhaps a forcible motion, in water and other bodies, to oppose a

vacuum. But I, that see nothing to be manifest here, save that some bodies, not devoid of weight, have a motion upwards, or otherwise differing from their usual motions, (as in determination, swiftness, &c.) am not apt, without absolute necessity, to ascribe to inanimate and senseless bodies, such as water, air, &c. the appetites and hatreds that belong to rational, or at least to sensitive, beings; and therefore think it a sufficient reason to decline employing such improper causes, if, without them, the motions, wont to be ascribed to them, can be accounted for.

2. If the Cartesian notion of the essence of a body be admitted by us, as it is by many modern philosophers and mathematicians, it can scarce be denied but that nature does not produce these oftentimes great, and oftner irregular, efforts to hinder a vacuum; since it being impossible there should be any, it were a fond thing to suppose that nature, who is represented to us as a most wise agent, should bestir herself, and do extravagant feats, to prevent an impossible mischief.

3. If the atomical hypothesis be admitted, it must be granted, not only that nature does not abhor a vacuum, but that a great part of the things she does require it, since they are brought to pass by local motion; and yet there are very many cases, wherein, according to these philosophers, the necessary motions of bodies cannot be performed, unless the corpuscles, that lie in their way, have little empty spaces to retire, or be impelled into, when the body, that pushes them, endeavours to displace them. So that the effatum, that nature abhors a vacuum, agrees with neither of the two great sects of the modern philosophers.

BUT, without insisting on the authority of either of them, I consider, that, for aught appears by the phenomena employed to demonstrate nature's abhorrency of a vacuum, it may be rational enough to think, either that nature does not abhor a vacuum, even when she seems solicitous to hinder it; or that she has but a very moderate hatred of it in that sense wherein the vulgar philosophers take the word vacuum.

FOR if we consider, that in almost all visible bodies here below, and even in the atmospherical air itself, there is more or less of gravity or tendency towards the centre of our terraqueous globe, we may perceive, that there is no need that nature should disquiet herself, and act irregularly, to hinder a vacuum; since, without her abhorrence of it, it may be prevented, or replenished, by her affecting to place all heavy bodies as near the centre of the earth as heavier than they will permit. And even without any design of hers, not to say without her existence, a vacuity will be as much opposed, as we really find it to be, by the gravity of most, if not of all, bodies here below, and the confluxibility of liquors and other fluids: for by virtue of their gravity, and the minuteness of their parts, they will be determined to insinuate themselves into and fill all the spaces that they do not find already possessed by other bodies, either more ponderous in specie than themselves, or, by reason of their firmness of structure, capable of resisting or hindring their descent. Agreeably to which notion we may observe, that, where there is no danger of a vacuum, bodies may move as they do when they are said to endeavour its prevention: as if you would thrust your fist deep into a pail full of sand, and afterwards draw it out again, there will need nothing but the gravity of the sand to make it fill up the greatest part of the space deserted by your fist; and if the pail be replenished, instead of sand, with an aggregate of corpuscles more minute and glib than the grains of sand, as for instance, with quicksilver or with water; then the space, deserted by your hand, will be, at least as to sense, compleatly filled up by the corpuscles of the liquor, which, by their gravity, minuteness, and the fluidity of the body they compose, are determined to replenish the space deserted by the hand that was plunged into either of those liquors.

And

And I elsewhere shew, that if you take a pipe of glass, whose cavity is too narrow to let water and quicksilver pass by one another in it; if, I say, you take such a pipe, and having (by the help of suction) lodged a small cylinder of mercury of about half an inch long in the lower part of it, you carefully stop the upper orifice with the pulp of your finger, the quicksilver will remain suspended in the pipe: and if then you thrust the quicksilver directly downwards into a somewhat deep glass, or other vessel, full of water, till the quicksilver be depressed about a foot or more beneath the surface of the water; if then you take off your finger from the orifice of the pipe, which it stopt before, you shall immediately see the quicksilver ascend swiftly five or six inches, and remain suspended at this new station. Which experiment seems manifestly to prove, what I did long ago devise and do now alledge it for; since here we have a sudden ascent of so heavy a body, as is quicksilver, and a suspension of it in the glass, not produced to prevent or fill a vacuum, for the pipe was open at both ends, the phenomena being but genuine consequences of the laws of the æquilibrium of liquors, as I elsewhere clearly and particularly declare.

WHEN I consider, how great a power the school-philosophers ascribe to nature, I am the less inclined to think, that her abhorrence of a vacuum is so great, as they believed. For I have shewn in the fifth section, that her aversion from it, and her watchfulness against it, are not so great, but that, in the sense of the Peripatetics, she can quietly enough admit it in some cases, where, with a very small endeavour, she might prevent or replenish it, as I have particularly manifested in the fore-cited section. I just now mentioned a vacuum in the sense of the Peripatetics, because when the Torricellian experiment is made, though it cannot, perhaps, be cogently proved, either against the Cartesians, or some other Plenists, that in the upper part of the tube deserted by the quicksilver there is a vacuum, in the strict philosophical sense of the word; yet as the Peripatetics declare their sense by divers of their reasonings against a vacuum mentioned in that section, it will to a heedful peruser appear very hard for them to shew, that there is not one in that tube. And as by the school-men's way of arguing nature's hatred of a vacuum from the suspension of water and other liquors in tubes and conical watering-pots, it appears, that they thought, that any space here below deserted by a visible body, not succeeded by another visible body, or at least by common air, may be reputed empty; so, by the space deserted by the quicksilver at the top of the pipe of a baroscope thirty-one inches long, one may be invited to doubt, whether a vacuum ought to be thought so formidable a thing to nature, as they imagine she does, and ought to think it? For what mischief do we see ensue to the universe upon the producing or continuance of such a vacuum, though the deserted space were many times greater than an inch, and continued many years, as has divers times happened in the taller sort of mercurial baroscopes? And those Peripatetics, that tell us, that, if there were a vacuum, the influences of the celestial bodies, that are absolutely necessary to the preservation of sublunary ones, would be intercepted, since motion cannot be made in vacuo, would do well to prove, not suppose, such a necessity; and also to consider, that in our case the top of the quicksilver, to which the vacuum reaches, does usually appear protuberant; which shews, that the beams of light (which they think of great affinity to influences, if not the vehicle) are able to traverse that vacuum, being in spite of it reflected from the mercury to the beholder's eye. And in such a vacuum, as to common air, I have tried, that a load-stone will emit its effluvia, and move iron or steel placed in it. In short, it is not evident, that here below nature so much strains herself to hinder or fill up a vacuum, as to manifest an abhorrence of it. And without much peculiar solicitude, a vacuum, at least a philosophical one, is as
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much

much provided against, as the welfare of the universe requires, by gravity and confluxibility of the liquors and other bodies, that are placed here below. And as for those, that tell us, that nature abhors and prevents a vacuum, as well in the upper part of the world as the lower, I think we need not trouble ourselves to answer the allegation, till they have proved it: which I think will be very hard for them to do; not to mention, that a Cartesian may tell them, that it were as needless for nature to oppose a vacuum in heaven as in earth, since the production of it is every where alike impossible.

Hippocrat.
Epidem.
l. 6. § 5.
l. 1.

VI. I come now to the celebrated saying, that *natura est morborum medicatrix*, taken from *Hippocrates*, who expresses it in the plural, *ἡ φύσις ἰατρὴν*. And because this axiom is generally received among physicians and philosophers, and seems to be one of the principal things, that has made them introduce such a being, as they call nature, I think it may be time well employed, to consider somewhat attentively, in what sense, and how far, this famous sentence, may, or should not, be admitted.

FIRST then, I conceive it may be taken in a negative sense, so as to import, that diseases cannot be cured in such persons, in whom the aggregate of the vital powers or faculties of the body is so far weakened or depraved, as to be utterly unable to perform the functions necessary to life, or at least to actuate and assist the remedies employed by the physician to preserve or recover the patient. This I take to be the meaning of such usual phrases, as, that physic comes too late, and that nature is quite spent: and in this sense I readily acknowledge the axiom to be true; for, where the engine has some necessary parts, whether fluid or solid, so far depraved or weakened, as to render it altogether unable to co-operate with the medicine, it cannot be rationally expected, that the administration of that medicine should be effectual; but in this, I presume, there is no difficulty worthy to detain us. I proceed therefore to the positive sense, whereof our axiom is capable, and wherein it is the most usually employed: for men are wont to believe, that there resides in the body of a sick person a certain provident or watchful being, that still industriously employs itself, by its own endeavours, as well as by any occasional assistance, that may be afforded it by the physician, to rectify whatever is amiss, and restore the distempered body to its pristine state of health. What I think of this doctrine I shall leave you to gather from the following discourse.

I CONCEIVE then in the first place, that the wise and beneficent Maker of the world and of man, intending, that men should, for the most part, live a considerable number of years, in a condition to act their part on the mundane stage; He was pleased to frame those living automata, human bodies, that, with the ordinary succours of reason, making use of their exquisite structure fitted for durableness, and of the friendly, though undesigned, assistance of the various bodies, among which they are placed, they may in many cases recover a state of health, if they chance to be put out of it by lesser accidents than those, that God, in compliance with the great ends of his general providence, did not think fit to secure them from, or enable them to surmount. Many things therefore, that are commonly ascribed to nature, I think, may be better ascribed to the mechanisms of the macrocosm and microcosm, I mean, of the universe and the human body. And, to illustrate a little my meaning by a gross example or two, I desire you will consider with me a sea-compass, wherein the excited magnetic needle, and the box that holds it, are duly poised by means of a competent number of opposite pivots: for though, if you give this instrument a somewhat rude shake, you will make the box totter, and encline this way and that way, and at the same time drive the points of the magnetic needle many degrees to the east,

or

or to the west; yet, the construction of the instrument and the magnetism of one main part of it are such, that if the force, that first put it into a disorderly motion, cease from acting on it, the box will, after some reciprocations, return to its horizontal situation; and the needle, that was forced to deviate, will, after a few irregular motions to this and to that side of the magnetical meridian, settle itself again in a position, wherein the flower-de-luce stedfastly regards the north. And yet this recovery to its former state is effected in a factitious body, by the bare mechanism of the instrument itself, and of the earth, and other bodies, within whose sphere of activity it is placed. But because many have not seen a mariner's compass, I will add a less apposite, but more obvious and familiar example: for if, when an empty balance is duly counterpoised, you shall, by your breath or hand, depress one of the scales, and thereby, for the time, destroy the *Equilibrium*; yet, when the force is once removed, the depressed balance will presently ascend, and the opposite will descend; and, after a few motions up and down, they will both of them, of their own accord, settle again in an exact *Equilibrium*, without the help of any such provident internal principle, as nature; the absence of whose agency may be confirmed by this, that the depressed scale does not at first stop at the horizontal line, beneath which it was first depressed, (as it ought to do, if it were raised by an intelligent being) but rises far above it. If it be here objected, that these examples are drawn from factitious, not from merely physical bodies; I shall return this brief answer, and desire, that it be applied not only to the two freshly mentioned examples, but to all of the like kind, that may be met with in this whole treatise. I say then, in short, that divers of the instances we are speaking of are intended but for illustrations, and that others may be useful instances, if they should be no more than analogous ones; since examples drawn from artificial bodies and things may have both the advantage of being more clearly conceived by ordinary understandings, and that of being less obnoxious to be questioned in that particular, in which the comparison or correspondence consists: and I the less scruple to employ such examples, because *Aristotle* himself and some of his more learned followers make use of divers comparisons drawn from the figures and other accidents of artificial things, to give an account of physical subjects, and even of the generation, corruption, and forms of natural bodies. This advertisement premised, I pursue this discourse it interrupted, by adding, thus in a human body the causes, that disorder it, are oftentimes but transient; whereas the structure of the body itself, and the causes, that conduce to the preservation of that structure, are more stable and durable, and on that account may enable the engine to out-last many things that are hostile to it. This may be somewhat illustrated, by considering, that sleep, though it be not properly a disease, easily becomes one, when it frequently transgresseth its due bounds; and even whilst it keeps within them, it does, for the time it lasts, hinder the exercise of many functions of the body more than several diseases do; and yet, according to the common course of things, the matter, that locked up the senses, being spent, the man of himself recovers that sensible and active state, on whose score he is said to be awake. But to come somewhat closer to the point, we see, that many persons, who get a præternatural thirst with over-much drinking, get rid of it again in a few days by forbearing such excesses; and many, that by too plentiful meals are brought to a want of appetite, recover, as it were, of course, by a spare diet, in a few days; the renewed ferment, or menstruum of the stomach, being able in that time to concoct by little and little, or expel the indigested aliments or peccant humours, that offended the stomach, and caused the want of appetite.

AND here I desire to have it taken notice of, as a thing, that may be considerable to our present purpose, that I look not on a human body, as on a watch or a hand-mill, *i. e.* as a machine made up only of solid, or at least consistent parts; but as an hydraulical, or rather hydraulpneumatical engine, that consists not only of solid and stable parts, but of fluids, and those in organical motion: and not only so, but I consider, that these fluids, the liquors and spirits, are in a living man so constituted, that in certain circumstances the liquors are disposed to be put into a fermentation or commotion, whereby either some depuration of themselves, or some discharge of hurtful matter by excretion, or both, are produced, so as, for the most part, to conduce to the recovery or welfare of the body.

AND that even consistent parts may be so framed, and so connected with other parts, as to act, as it were, *pro re nata*, varying their motions as differing circumstances make it convenient they should be varied, I purposely shew in another paper. To this I might altogether refer you; but, in regard the thing is a paradox, and lays a foundation for another not inferior to itself, I shall here borrow thence one instance, not mentioned that I know of by others to this purpose, that may both declare my meaning, and confirm the thing itself. I consider then, that what is called the pupil or apple of the eye, is not (as it is known) a substantial part of the organ, but only a round hole or window made in the uvea, at which the modified beams of light enter, to fall upon the chrystalline humour, and thence be refracted to the bottom of the eye, or seat of vision, to make there an impresson, that is usually a kind of picture (for it is not always a neat one) of the object. Now the wise and all-foreseeing Author of things has so admirably contrived this instrument of sight, that, as it happens to be employed in differing lights, so the bigness or area of the pupil varies; for when the light is vivid, and would be too great, if all the beams were let in, that might enter at an aperture as large as the usual, the curtain is every way drawn towards the middle, and thereby the round window made narrower; and, on the other side, when the light is but faint, and the object but dimly illustrated, there being more light requisite to make a sufficient impresson at the bottom of the eye, the curtain is every way drawn open, to let in more light: and when the eye is well constituted, this is regularly done, according as the organ has need of more or less light. Of this some late masters of optics have well treated, and I have spoken about it more fully in another place. And the truth of the observation you may easily find, if you look upon the eyes of a boy or a girl (for in young persons the change is the most notable) when the eyes are turned from looking on dark objects towards bright or more illuminated ones. And I have found the variation yet more conspicuous in the eyes of a young cat, as I elsewhere particularly relate. So that, referring you to the writings already pointed at, I shall only add in this place, that these various motions in the eye are produced by mere mechanism, without the direction, or so much as knowledge or perception of the rational soul. And, upon the like account it is, that other motions, in several parts belonging to the eye, are produced, as it were spontaneously, as occasion requires. And so, as to the fluid parts of the body, we find, that, according to the institution of the Author of things, when healthy women are of a fit age, there is a monthly fermentation or commotion made in the blood, which usually produces a kind of separation, and then an excretion, advantageous to the body.

AND that you may the better make out what I meant by the disposition, or tendency, of the parts, to return to their former constitution, I shall desire you to consider, with me, a thin and narrow plate of good steel, or refined silver; for, if one end of it be forcibly drawn aside, the changed texture of the parts becomes such,

or the congruity and incongruity of the pores, in reference to the ambient æther, that endeavours to permeate them, is made such, that, as soon as the force, that bent it, is removed, the plate does, as it were, spontaneously return to its former position: and yet here is no internal watchful principle, that is solicitous to make this restitution, for otherwise it is indifferent to the plate what figure it settle in: for, if the springy body stand long bent, then, as if nature forgot her office, or were unable to execute it, though the force, that held the spring bent, be removed, it will not endeavour to regain its former straightness. And I have tried in a silver plate, that if you only heat it red-hot, and let it cool, if you put it into a crooked posture, it will retain it; but barely with two or three strokes of a hammer, which can only make an invisible change of texture, the plate will acquire a manifest and considerable springyness, which you may again deprive it of, by sufficiently heating it in the fire, without so much as melting it.

BUT, to return to the discourse, formerly begun, about distempers wont to be harmless by being transient, we may observe, that the third or fourth day after women are brought to bed there is commonly a kind of fever produced, upon the plentiful resort of the milk to the breasts; for which cause, this distemper is, by many, called the fever of milk; and this is wont, in a short time, to pass away of itself, as depending upon causes far less durable, than the œconomy of the woman's body. And if it be objected, that these are not diseases, because they happen according to the instituted course of nature; I will not now dispute the validity of the consequence, though I could represent, that the labour of teeming women, and the breeding of teeth in children, happen as much according to the institution of nature, and yet are usually very painful, and oftentimes dangerous; but I will rather answer, that if the troublesome accidents, I have alledged, cannot serve to prove, they may at least to illustrate, what I aim at. And I shall proceed to take notice of a distemper, that physicians generally reckon among diseases, I mean the flowing of blood at the hæmorrhoidal veins: for, though oftentimes this flux of blood is excessive, and so becomes very dangerous, and therefore must be checked by the physician, (which is no great argument, that a being, wise and watchful, manages this evacuation); yet frequently, if not for the most part, the constitution of the body is such, that the superfluous or vitiated blood goes off, before it has been able to do any considerable mischief, or perhaps any at all, to the body. And so we see, that many coughs, and hoarsenesses, and coryzas are said to be cured, that is, do cease to trouble men, though no medicine be used against them, the structure of the body being durable enough to out-last the peccant matters, or the operation of those other causes, that produce these distempers.

IT is a known thing, that most persons, the first time they go to sea, especially if the weather be any thing stormy, are, by the unwonted agitations, which those of the ship produce in them, (assisted perhaps by the sea-air, and smells of the ship) cast into that disease, that, from the cause of it, is called the sea-sickness, which is sometimes dangerous, and always very troublesome, usually causing a loss of appetite, and almost continual faintness, a pain in the head, and almost constant nauseousness, accompanied with frequent, and oftentimes violent vomitings; which symptoms make many complain, that, for the time, they never felt so troublesome a sickness; and yet usually, after not many days, this distemper, by degrees, is mastered by the powers of the body, tending still to persevere in their orderly and friendly course, and suppressing the adventitious motions, that oppose it, and the sick person recovers without other help. And so, though persons unaccustomed to the sea, whether they be sick or no, are, by the inconvenient motions of the ship, usually brought to a kind

of habitual giddiness, which disposes them to reel and falter, when they walk upon firm ground; yet, when they come a-shore, they are wont in no long time to be freed from this uneasy giddiness, without the help of any medicine; the usual and regular motions of the parts of the body obliterating by degrees in a few days (I used to be free from it within some hours) that adventitious impression, that caused the discomposure. To the same purpose we may take notice of that, which happens to many persons, who riding backwards in a coach are not only much distempered in their heads, but are made very sick in their stomachs, and forced to vomit, as violently and frequently, as if they had taken an emetic; and yet all this disorder is wont quickly to cease, when the patient leaves the coach, without the continuance of whose motion (that continues a preposterous one in some parts of the patient) the distemper will quickly yield to the more ordinary and regular motions of the blood, and other fluids of the body. So, when in a coach, or elsewhere, a man happens to be brought to faintness, or cast into a swoon, by the closeness of the place, or the over-charging of the air with the fuliginous reeks of men's bodies; though the disease be formidable, yet, if the patient be seasonably brought into the free air, the friendly operation of that external body, assisting the usual endeavours or tendency of the parts of the patient's body to maintain his life and health, is wont quickly to restore him to the state he was in before this sudden sickness invaded him. Divers things, that happen in some diseases, may be grossly illustrated, by supposing, that into a vial of fair water some mud be put, and then the vial be well shaken, for the water will be troubled and dirty, and will lose its transparency, upon a double account; that of the mud, whose opacous particles are confounded with it; and that of the newly generated bubbles, that swim at the top of it: and yet to clarify this water, and make it recover its former limpidness, there needs no particular care or design of nature, but, according to the common course of things, after some time the bubbles will break and vanish at the top, and the earthy particles, that compose the mud, will, by their gravity, subside to the bottom, and settle there, and so the water will become clear again. Thus also must, which is the lately expressed juice of grapes, will for a good while continue a troubled liquor; but though there be no substantial form to guide the motions of this factitious body, yet, according to the course of things, a fermentation is excited, and some corpuscles are driven away in the form of exhalations or vapours, others are thrown against the sides of the cask, and hardened there into tartar, and others again subside to the bottom, and settle there in the form of lees; and by this means leave the liquor clear, and, as to sense, uniform. And why may not some depurations and proscriptions of heterogeneous parts be made in the blood, as well as they are usually in must, without any peculiar and solicitous direction of nature?

THERE is indeed one thing, to which the sentence of nature's being the curer of diseases may be very speciously applied, and that is the healing of cuts and wounds, which, if they be but in the flesh, may oftentimes be cured without plaisters, salves, or other medicines, but, not to mention hæmorrhages and some other symptoms, wherein the surgeon is fain to curb or remedy the exorbitancies of nature, this healing of the *solutio continui* seems to be but an effect or consequent of that fabric of the body on which nutrition depends: for the alimental juice, being, by the circulation of the blood and chyle, carried to all parts of the body to be nourished, if it meets any where either with preternatural concretions, or with a gap made by a cut or wound, its particles do there concrete into a kind of bastard-flesh, or some such other body, which that juice, in the place and other circumstances it is in, is fitted to constitute. Thus we see, that not only wens and scrophulous tumors are nourished in the body, but mis-shapen molas do by nutriment grow in the womb,

as well as embryos feed there. And, to come closer to the present argument, we see, that in wounds proud-flesh, and perhaps funguses, are as well produced and entertained by the aliment brought to the wounded part, as the true and genuine flesh; so that either nature seems much mistaken, if she designs the production and maintenance of such superfluous and inconvenient bodies; or the surgeon is much to blame, who is industrious to destroy them, though oftentimes he cannot do it, without using painful corrosives. But, for aught appears, nature is not so shy and reserved in her bounty, but that she sends nourishment to repair as well things, that do not belong to the body, as genuine parts of it, as to restore flesh to wounded parts; as may appear by warts and corns, that grow again after they are skilfully cut. And I remember I have seen a woman, in whose forehead nature was careful to nourish a horn about an inch and more in length, which I fully examined, whilst it was yet growing upon her head, to avoid being imposed upon.

BUT, besides the diseases hitherto discoursed, there are many others, as well acute as chronical, wherein it is confessed, that nature alone does not work the cure; so that as to these, (which are more numerous than the former) I may well pretend, that the aphorism, that makes nature the curer of diseases, is not true, otherwise than in a limited sense. But because I know it is pretended, that even in these diseases nature is the principal agent, by whose direction the physician acts in subseriency to her designs, and physicians themselves (whether out of modesty or inadvertence, I now inquire not) are wont to acknowledge, that they are but nature's ministers; I think it necessary to consider briefly, what sense is fit, according to our doctrine, to be given to these assertions, to make them receivable by us.

BUT, to make way for what we are to say on this occasion, it may be fit to observe, that one great cause of the common mistakes about this matter is, as hath been partly intimated already, that the body of a man is looked upon, rather as a system of parts, whereof most are gross and consistent, and not a few hard and solid too, than as, what indeed it is, a very compounded engine, that, besides these consistent parts, does consist of the blood, chyle, gall, and other liquors, also of more subtil fluids, as spirits and air; all which liquors and fluids are almost incessantly and variously moving, and thereby put divers of the solid parts, as the heart and lungs, the diaphragma, the hands, feet, &c. into frequent and differing motions: so that, as, when the constitution or the motions, that in a sound body do regularly belong to the fluid parts, happens the former to be depraved, or the latter to grow anomalous, the engine is immediately out of order, though the gross solid parts were not primarily affected; so, when by proper remedies (whether visible or not) the vitiated texture or crasis of the blood or other juices is corrected, and the inordinate motions, that they and the spirits are put into, or, that they also put the consistent parts into, are calmed and rectified, the grosser and more solid parts of the body, and so the whole animal œconomy, if I may so call it, will be restored to a more convenient state. Thus we see, that in many hysterical women, by the fragrant effluvia of a *Spanish* glove, or some other strong perfume, the spirits and *genus nervosum* being affected, several disorderly symptoms are produced, and oftentimes the motion of the blood is so stopt and abated, that any pulse at all is scarcely to be felt, nor respiration discerned, and the whole engine, unable to sustain itself, falls to the ground, and lies moveless on it; and yet we have often, by barely holding to the patient's nostrils a vial full of very strong spirit, or volatile salt, or sal-armoniac, or of hartshorn, in less than a quarter of an hour, sometimes in a few minutes, restored women in that condition to their senses, speech, and motion.

WE are also here to consider, what I have formerly inculcated, that the œconomy of the human body is so constituted by the divine Author of it, that it is usually fit-

ted to last many years, if the more general laws, settled by the same Author of the universe, will permit it: and therefore it is not to be wondered at, that in many cases the automaton should be in a condition to concur, though not with knowledge and design, to its own preservation, when, though it had been put somewhat out of order, it is assisted by the physician's hands or medicines to recover a convenient state.

AND if it be objected, that the examples, that have been in this past discourse frequently drawn from automata, are not adequate, and do not fully reach the difficulties we have been speaking of, I shall readily grant it, provided it be considered, that I avowedly and deservedly suppose the bodies of living animals to be, originally, engines of God's own framing, and consequently effects of an omniscient and almighty artificer. So that, it is not rational to expect, that in the incomparably inferior productions of human skill, there should be found engines fit to be compared with these, which in their protoplasts had God for their author. Not to mention (what yet may be considerable in reference to the lastingness of human life) that a man is not a mere mechanical thing, where nothing is performed for the preservation of the engine, or its recovery to a good state, but by its own parts, or other agents, acting according to mechanical laws without counsel or design; since, though the body of a man be indeed an engine, yet there is united to it an intelligent being (the rational soul or mind) which is capable, especially if instructed by the physician's art, to discern, in many cases, what may hurt it, and what may conduce to the welfare of it, and is also able (by the power it has to govern the muscles and other instruments of voluntary motion) to do many of those things it judges most conducive to the welfare and safety of the body, it is joined with. So that a man is not like a watch, or an empty boat, where there is nothing but what is purely mechanical; but like a manned boat, where, besides the mechanical part (if I may so speak) there is an intelligent being, that takes care of it, and both steers it, or otherwise guides it, and when need requires, trims it; and, in a word, as occasion serves, does what he can to preserve it, and keep it fit for the purposes it is designed for.

THESE things being premised, I think the physician (here supposed to be free from prejudices and mistakes) is to look upon his patient's body, as an engine, that is out of order, but yet is so constituted, that, by his concurrence with the endeavours, or rather tendencies, of the parts of the automaton itself, it may be brought to a better state. If therefore he find, that in the present disposition of the body there is a propensity or tendency to throw off the matter, that offends it, and (which ought to be some way or other expelled) in a convenient way, and at commodious places; he will then act so, as to comply with, and further, that way of discharge, rather than another: as, if there be a great appearance, that a disease will quickly have a crisis by sweat; he will rather further it by covering the patient with warm cloaths and giving sudorific medicines, than by endeavouring to carry off the peccant matter by purging or vomiting, unseasonably hinder a discharge, that probably will be beneficial. And in this sense men may say, if they please, that the physicians are ministers or servants of nature; as seamen, when the ship goes before a good wind, will not shift their sails, nor alter the ship's motion, because they need not. But to shew, that it is, as it were, by accident, that the physician does, in the fore-mentioned case, obey nature, (to speak in the language of the naturists I reason with), I need but represent, that there are many other cases, wherein the physician, if he be skilful, will be so far from taking nature for his mistress, to direct him by her example, what should be done; that a great part of his care and skill is employed to hinder her from doing what she seems to design, and to bring to pass other things very different from, if not contrary to, what she endeavours.

THUS,

THUS, though nature in dropſies importunately crave ſtore of drink, the phyſician thinks himſelf obliged to deny it; as he does what they greedily deſire, to his patients of the green-ſickneſs, or that diſtemper they call pica, though the abſurd and hurtful things, as very unripe fruit, lime, coals, and other incongruous things, be earneſtly longed for. Thus alſo the chirurgeon does often hinder nature from cloſing up the lips of a wound, as ſhe would unſkilfully do, before it be well and ſecurely healed at the bottom. So the phyſician does often, by purging or phlebotomy, carry off that matter, that nature would more dangerously throw into the lungs, and expel by frequent and violent coughs.

And ſo, if a nerve or tendon be pricked, the chirurgeon is ſain, with anodynes, and other convenient medicines, to prevent or appeaſe the unreaſonable tranſports of nature, when, being in a fury, by violent and threatening convulſions, ſhe not only much diſorders, but endangers, the patient. And ſo likewiſe, when in thoſe evacuations, that are peculiar to women, nature affects, in ſome individuals, to make them by undue and inconvenient places, as the nipples, the mouth, or the eyes, whereof we have divers inſtances, among the obſervations collected by *Schenckius*, or *Schenck.* related by other good authors; the phyſician is careful, by bleeding the patient in *Obſervat.* the foot, and by uſing other means, to oblige nature to alter her purpoſe, and make *l. iv. pag.* the intended evacuations by the proper uterine veſſels: and though, according to the *m. 633. & ſeq.* inſtitution of nature, as they ſpeak, there ought to be a monthly diſcharge of theſe ſuperfluities, and therefore, whiſt this is moderately made, the phyſician does rather further than ſuppreſs it, yet if, as it often happens in other patients, nature overlaſhes in making thoſe evacuations, to the great weakning or endangering the ſick perſon, the phyſician is careful, by contemporating medicines and other ways, to correct nature's exorbitancy, and check her profuſeneſs of ſo neceſſary a liquor, as the blood. Other inſtances, more conſiderable, than ſome of theſe hitherto mentioned, might be given to the ſame purpoſe; but I forbear to do it, becauſe, there being ſome, though perhaps very needleſs, controverſies about them, I could not make out their fitneſs to be here alledged, without more words, than I am now willing to employ about unneceſſary proofs, fearing it might be thought I have dwelt too long already upon the explication of one aphoriſm. I ſhall therefore only obſerve in ſhort, that I look upon a good phyſician, not ſo properly as a ſervant to nature, as one, that is a counſellor and friendly aſſiſtant, who, in his patient's body, furthers theſe motions and other things, that he judges conducive to the welfare and recovery of it; but as to thoſe, that he perceives likely to be hurtful, either by increaſing the diſeaſe, or otherwiſe endangering the patient, he thinks it is his part to oppoſe or hinder, tho' nature do manifeſtly enough ſeem to endeavour the exerciſing or carrying on thoſe hurtful motions.

ON this occaſion, I ſhall take notice of the practice of the more prudent among phyſicians themſelves, who being called to a patient ſubject to the flux of the hæmorrhoids, if they find the evacuation to be moderate, and likely either to benefit the patient on another account, (as in ſome caſes it is), or at leaſt to end well, they do, as ſome of them ſpeak, commit the whole buſineſs to nature; that is, to ſpeak intelligibly, they ſuffer it to take its courſe, being encouraged to do ſo, in ſome caſes, by the doctrine of *Hippocrates*, and in others by experience: but if the evacuation prove to be too laſting, or too copious, they then are careful to hinder nature from proceeding in it, and think themſelves obliged to employ both inward and outward means to put a ſtop to an evacuation, which may bring on a dropſy, or ſome other formidable diſeaſe. And if it be ſaid, that nature makes this profuſion of ſo neceſſary a liquor as blood, only becauſe ſhe is irritated by the acrimony of ſome humour mixed with

with it; I say, that this answer, which, for substance, is the very same, that naturists may be compelled to fly to on many occasions, is in effect a confession, that nature is no such wise being as they pretend; since she is so often provoked to act, as it were, in a fury, and do those things in the body, that would be very mischievous to it, if the physician, more calm and wise than she, did not hinder her. So that, notwithstanding the reverence I pay the great *Hippocrates*, it is not without due caution and some limitations, that I admit that notable sentence of his, where he thus speaks; * *Invenit natura ipsa sibi-ipsi aggressiones*: and after three or four lines, *Non edocta natura & nullo magistro usa, ea quibus opus est facit*. Which, I fear, makes many physicians less courageous and careful than they should, or perhaps would be, to employ their own skill on divers occasions, that much require it.

* *Hippoc.*
Epidem.
l. vi. § 5.
text. 2. 4.

I SHALL now add, that as, in some cases, the physician relieves his patient in a negative way, by opposing nature in her unseasonable or disorderly attempts; so, in other cases, he may do it in a positive way, by employing medicines, that either strengthen the parts, as well fluid as stable, or make sensible evacuations of matters necessary to be proscribed by them; or (he may do it) by using remedies, that by their manifest qualities oppugn those of the morbid matter or causes; as when by alcalies or absorbing medicaments he mortifies preternatural acids, or disables them to do mischief. And, perhaps, one may venture to say, that, in some cases, the physician may, in a positive way, contribute more to the cure even of an inward disease, than nature herself seems able to do: for if there be any such medicine preparable by art, as *Helmont* affirms may be made of *Paracelsus's Ludus*, by the liquor alkahest; or, as *Cardan* relates, that an empiric had in his time, who travelled up and down *Italy*, curing those, wherever he came, that were tormented with the stone in the bladder; if, I say, there be any such medicines, the physician may, by such instruments, perform that, which, for aught appears, is not to be done by nature herself, since we never find, that she dissolves a confirmed stone in the bladder: nay, sometimes the physician does, without the help of a medicine, controul and over-rule nature, to the great and sudden advantage of the patient. For when a person, otherwise not very weak, happens by a fright, or some surprising ill news, to be so discomposed, that the spirits hastily and disorderly thronging to some inward part, especially the heart, hinder the regular and wonted motion of it, by which disorder the circulation of the blood is hindered, or made very imperfect; in this case, I say, the patient is by nature's great care of the heart (as is commonly supposed even by physicians) cast into a swoon, whence the physician sometimes quickly frees him, by rubbing and pinching the limbs, the ears and the nose, that the spirits may be speedily brought to the external parts of the body; which must be done by a motion to the circumference (as they call it), quite opposite to that towards the centre or heart, which nature had given them before. But as to the theory of swoonings, I shall not now examine its truth, it being sufficient to warrant my drawing from thence an argument *ad hominem*, that the theory is made use of by those I reason with.

By what has been discoursed one may perceive, that as there are some phænomena, that seem to favour the doctrine of the naturists about the cure of diseases, so there are others, that appear more manifestly favourable to the hypothesis we propose. And both these sorts of phænomena being considered together, may well suggest a suspicion, that the most wise and yet most free Author of things having framed the first individuals of mankind so, as to be fit to last many years, and endowed those protoplasts with the power of propagating their species; it thereupon comes to pass, that in the subsequent hydraulico-pneumatical engines we call human bodies, when neither particular providence, nor the rational soul, nor over-ruling impediments inter-

pose, things are generally performed according to mechanical laws and courses; whether the effects and events of these prove to be conducive to the welfare of the engine itself, or else cherish and foment extraneous bodies or causes, whose preservation and prospering are hurtful to it. On which supposition it may be said, that the happy things, referred to nature's prudent care of the recovery and welfare of sick persons, are usually genuine consequences of the mechanism of the world, and the patient's body; which effects luckily happen to be co-incident with his recovery, rather than to have been purposely and wisely produced in order to it; since I observe, that nature seems to be careful to produce, preserve, and cherish things hurtful to the body, as well as things beneficial to it. For we see in the stone of the kidneys and bladder, that out of vegetable or animal substances of a slighter texture, such as are the alimential juices, which, in sucking children (who are observed to be frequently subject to the stone in the bladder) are afforded by so mild a liquor as milk; nature skilfully frames a hard body of so firm a texture, that it puzzles physicians and chymists to tell, how such a coagulation can be made of such substances: and I have found more than one calculus to resist both spirit of salt, that readily dissolves iron and steel, and that highly corrosive menstruum, oil of vitriol itself. We see also, that divers times the seeds or seminal principles of worms, that lie concealed in unwholesome fruits, and other ill qualified aliments, are preserved and cherished in the body so, as, in spite of the menstruum's ferments, &c. they meet with there, they grow to be perfect worms (of their respective kinds) that are often very troublesome, and sometimes very dangerous, to the body that harbours them; producing, though perhaps not immediately, both more and more various distempers (especially here in *England*) than every physician is aware of. This reflection may very well be applied to those instances we meet with in good * authors, of frogs, and even toads, whose * *Schenck's* spawn, being taken in with corrupted water, hath been cherished in the stomach, *Observ.* until the eggs being grown to be compleat animals, they produced horrid symptoms *lib. iii.* in the body, that had lodged and fed them. And if, according to the received *pag. mihi* opinion of physicians, stubborn quartans are produced by a melancholy humour *337. & seq.* seated in the spleen, it may be said, that nature seems to busy herself to convert some parts of the fluid chyle into so tenacious and hardly dissippable a juice, that in many patients, notwithstanding the neighbourhood of the spleen and stomach, neither strong emetics, nor purges, nor other usual remedies, are able, in a long time, to dislodge it, or resolve it, or correct it. But that is yet more conducive to my present purpose, that is afforded me by the consideration of the poison of a mad dog, which nature sometimes seems industriously and solicitously to preserve; since we have instances in approved authors, that a little foam conveyed into the blood by a slight hurt (perhaps quickly healed up) is, notwithstanding the constant heat and perspirable frame of the human body, and the dissippable texture of the foam, so preserved, and that sometimes for many years, that, at the end of that long time, it breaks out, and displays its fatal efficacy with as much vigour and fury, as if it had but newly been received into the body.

To this agrees that, which is well known in *Italy*, about the biting of the tarantula; for, though the quantity of poison can scarce be visible, since it is communicated by the tooth of so small an animal as a spider, yet, in many patients, it is preserved during a great part of their lives, and manifests its continuance in the body by annual paroxysms. And I know a person of great quality, who complained to me, that, being in the East, the biting or stinging of a creature, whose offensive arms were so small, that the eye could very hardly discern the hurt, had so lasting an effect upon him, that, for about twelve years after, he was reminded of his mischance,

by

by a pain he felt in the hurt place, about the same time of the year, that the mischief was first done him. And, in some hereditary diseases, as the gout, falling-sickness, and some kinds of madness, nature seems to act, as if she did, with care as well as skill, transmit to the unhappy child such morbid seeds or impressions of the parent's disease, that, in spite of all the various alterations the younger body passes through, during the course of many years, this constantly protected enemy is able to exert its power and malice, after forty, or perhaps fifty, years concealment. Such reflections as these, to which may be added, that the naturists make no scruple to stile that death, which men are brought to by diseases, a natural death, make me backward to admit the famed sentence of *Hippocrates* hitherto considered, *Morborum Natura Medici*, without limitations, especially those two, that are delivered in the fifth section; to which I refer you the rather, because they may help you to discern, that divers phenomena, that favour not the received notion of a kind and prudent being, as nature is thought to be, are yet very consistent with divine providence.

S E C T. VIII.

I HAVE now gone through so many of the celebrated axioms concerning nature, that I hope I may reasonably presume, that the other sentences of this kind, that my haste makes me leave unmentioned, will be thought capable of being fairly explicated, and with congruity to our hypothesis, by the help of the grounds already laid, since, with light variations, they may be easily enough improved, and applied to those other particulars, to which they are the most analogous.

BUT this intimation ought not to hinder me to make a reflection, that not only is pertinent to this place, but which I desire may have retrospect upon a great part of the whole precedent discourse. And it is this, that though we could not intelligibly explicate all the particular axioms about nature, and the phenomena of inanimate bodies, that are thought, but not by me granted, to favour them by mechanical principles; it would not follow that we must therefore yield up the whole cause to the naturists: for we have already shewn, and may do so yet further ere long, that the supposition of such a being, as they call nature, is far from enabling her partizans to give intelligible accounts of these and other phenomena of the universe. And though our doctrine should be granted to be, as well as that generally received about nature, insufficient to give good accounts of things corporeal; yet I shall have this advantage in this case, that a less degree of probability may serve, in arguments employed but to justify a doubt, than is required in those, that are to demonstrate an assertion.

IT is true, that the naturists tell us, that the nature they assert is the principle of all motions and operations in bodies; which infers, that in explicating them, we must have recourse to her. But before we acquiesce in, or confidently employ, this principle, it were very fit we knew what it is. This question I have discoursed of in the fifth section; but having there intimated a reference to another place, the importance, as well as difficulty of the subject, invites me to resume, in this place, the consideration of it; and both vary and add to what I formerly noted, that I may as well inculcate as clear my thoughts about it. I demand then of those, that assert such a nature, as is vulgarly described, whether it be a substance or an accident? If it be the latter, it should be declared, what kind of accident it is; how a solitary accident can have right to all those attributes, and can produce those numerous, manifold, and wonderful effects, that they ascribe to nature; and why a complex of such accidents, as are the mechanical affections of matter, (as figure, bulk, motion, &c.)

may not altogether as probably, as that accident they call nature, be conceived to have been instituted by the perfectly wise Author of the universe, to produce those changes among bodies, which are (at least for the most part) intelligibly referrible to them? And if things be not brought to pass by their intervention, it were very fit, as well as desirable, that we should be informed, by what other particular and intelligible means nature can effect them better, than they may be by that complex.

BUT if it be said, as by most it is, that the principle, called nature, is a substance, I shall next demand, whether it be a corporeal, or an immaterial one? If it be said to be an immaterial substance, I shall further ask, whether it be a created one, or not? If it be not, then we have God under another name, and our dispute is at an end, by the removal of its object or subject, which is said by the schools to be God's vicegerent, not God himself. But if nature be affirmed (as she is, at least by all Christian philosophers) to be a created being, I then demand, whether or no she be endowed with understanding, so as to know what she does, and for what ends, and by what laws she ought to act? If the answer be negative, the supposition of nature will be of very little use to afford an intelligible account of things; an unintelligent nature being liable to the objections, that will a little below be met with against the usefulness of nature, in case she be supposed a corporeal being. And though it should be said, that nature is endowed with understanding, and performs such functions as divers of the ancients ascribe to the soul of the world; besides that this hypothesis is near of kin to heathenism, I do not think, that they, who shall with many Grecian, and other philosophers, who preceeded Christianism, suppose a kind of soul of the universe, will find this principle sufficient to explicate the phænomena of it: for if we may compare the macrocosm and microcosm in this, as well as many are wont to do in other things, we may conceive, that, though nature be admitted to be endowed with reason, yet a multitude of phænomena may be mechanically produced, without her immediate intervention; as we see, that in a man, though the rational soul has so narrow a province to take care of, as the human body, and is supposed to be intimately united to all the parts of it; yet abundance of things are done in the body by the mechanism of it, without being produced by that soul. Of this we may alledge, as an instance, that, in sleep, the circulation of the blood, the regular beating of the heart, digestion, nutrition, respiration, &c. are performed without the immediate agency, or so much as the actual knowledge, of the mind: and, when a man is awake, many things are done in his body, not only without the direction, but against the bent of his mind; as often happens in cramps and other convulsions, coughing, yawnings, &c. Nay, though some brutes, as particularly apes, have the structure of many parts of their bodies very like that of the analogous ones of human bodies; yet that admirable work of the formation and organization of the fœtus, or little animal, in the womb, is granted by philosophers to be made by the soul of the brute (that is therefore said to be the architect of his own mansion) which yet is neither an incorporeal, nor a rational substance. And, even in a human fœtus, if we will admit the general opinion of philosophers, physicians, divines and lawyers, I may be allowed to observe, that the human body, as exquisite an engine as it is justly esteemed, is formed without the intervention of the rational soul, which is not infused into the body, till this hath obtained an organization, that fits it to receive such a guest; which is commonly reputed to happen about the end of the sixth week, or before that of the seventh. And this consideration leads me a little further, and prompts me to ask, how much, by the supposition or knowledge of the mind, (at the newly mentioned time) we are enabled to explicate the manner, how the forementioned functions of an embryo are performed, when at the end of six or seven weeks the rational soul supervenes and comes to be united to this living engine?

AND if it be urged, that nature being the principle of motion in bodies, their various motions, at least, which amount to a considerable part of their phænomena, must be explained by having recourse to her; I answer, that it is very difficult to conceive, how a created substance, that is immaterial, can, by a physical power or action move a body; the agent having no impenetrable part, wherewith to impel the corporeal *mobile*. I know, that God, who is an immaterial spirit, ought to be acknowledged the primary cause of motion in matter, because (as we may justly with *Monfieur Des Cartes* infer) motion not belonging to corporeal substance, as such, this must owe that to an incorporeal one. But then, I consider, that there is that infinite distance between the incomprehensible Creator, and the least imperfect order of his creatures, that we ought to be very cautious, how we make parallels between him and them, and draw inferences from his power and manner of acting to theirs; since he, for instance, can immediately act upon human souls, as having created them; but they are not able so to act upon another. And I think it the more difficult to conceive and admit, that, if nature be an incorporeal substance, she should be the greater mover of the mundane matter, because we see, that, in a human body, the rational soul, (which the school-philosophers assert to be an immaterial spirit) though vitally united to it, can only determine the motion of some of the parts, but not give motion to any, or so much as regulate it in most. And if nature be said to move bodies in another than a physical way, I doubt, whether the supposition of such a principle will be of much use to physiologers in explicating phænomena; since I shall scarce think him an inquisitive or a judicious doctor, who should imagine, that he explains, that it gives an intelligible and particular account of the astonishing symptoms of those strange diseases, that divers very learned and sober physicians impute to witchcraft, when he says, that those strange distortions and convulsive motions, for instance, and other prodigious effects, were produced by a wicked immaterial spirit, called a devil. But having to this purpose said more in another paper, which you may command the sight of, I shall not trouble you with it here.

THE past discourse opposes their opinion, who assert nature to be an immaterial creature; but because it is thought, that a greater number of philosophers, at least among the moderns, take her to be corporeal, I shall now address my discourse to their hypothesis. And though I might object, that, if nature be a body, it may be demanded, how she can produce, in men, rational souls, that are immaterial beings, and not capable to be produced by any subtiliation or other change of matter whatsoever? yet, waving this objection, I shall first demand, whether those, I reason with, believe nature, though corporeal, to act knowingly, *i. e.* with consciousness of what she does, and for pre-designed ends; or else to be blindly and necessarily moved and directed by a superior agent, endowed with (what she wants) an excellent understanding; and then I shall represent a few things, applicable to some one or other of the two answers, that may be made, and some to both.

AND first, the Cartesians would ask, how, if nature be a corporeal substance, we can conceive her capable of thinking? and, which is more, of being a most wise and provident director of all the motions, that are made in the corporeal world?

SECONDLY, a philosophizer may justly ask, how a corporeal being can so pervade, and, as it were, com-pen-etrates the universe, as to be intimately present with all its minute parts, whereof yet it is said to be the principle of motion?

THIRDLY, he may also demand, whence nature, being a material substance, comes itself to have motion, whereof it is said to be the principle? since motion does not belong to matter in itself, and a body is as truly a body, when it rests, as when it moves. And if it be answered, that the first cause, that is, God, did at first put it into

into motion; I reply, that the same cause may, at least as probably, be supposed to have put the unquestioned mundane matter into motion, without the intervention of another corporeal being, in whose conception (*i. e.* as it is matter) motion is not involved.

FOURTHLY, it may likewise be asked, how the laws of motion come to be observed or maintained by a corporeal being? which, as merely such, is either incapable of understanding them, or of acting with respect to them, or at least is not necessarily endowed with any knowledge of them, or power to conform to them, and to make all the parts of the unquestioned mundane matter to do so too.

FIFTHLY, and I do not see, how the taking in such an intelligent and undefigning principle will free our understandings from great difficulties, when we come to explicate the phænomena of bodies: for, as is elsewhere noted, if nature be a bodily creature, and acts necessarily, and (if I may so speak) fatally, I see no cause to look upon it but as a kind of engine; and the difficulty may be as great to conceive, how all the several parts of this supposed engine, called nature, are themselves framed and moved by the great Author of things, and how they act upon one another, as well as upon the undoubted mundane bodies; as it is to conceive, how, in the world itself, which is manifestly an admirably contrived automaton, the phænomena may, by the same Author (who was able to endow bodies themselves with active power, as well as he could, on other scores, make them causes) be produced by virtue, and in consequence, of the primitive construction and motions, that he gave it (and still maintains in it) without the intervention of such a thing, as they call nature: for this, as well as the world, being a corporeal creature, we cannot conceive, that either of them act otherwise, than mechanically. And it seems very suitable to the Divine Wisdom, that is so excellently displayed in the fabrick and conduct of the universe, to employ in the world, already framed and compleated, the fewest and most simple means, by which the phænomena, designed to be exhibited in the world, could be produced. Nor need we be much moved by hearing some naturists say, that nature, though not an incorporeal being, is of an order superior to mere matter; as divers of the schoolmen teach the things, they call material forms to be: for who can clearly conceive an order or kind of beings, that shall be real substances, and yet neither corporeal nor immaterial? Nor do I see, how the supposition of this unintelligible, or at least unintelligent being, though we should grant it to have a kind of life or soul, will much assist us to explicate the phænomena; as, if a man be acquainted with the construction of mills, he may as well conceive, how corn is ground by a mill driven by the wind or by a stream of water, which are brute and senseless beings, as he can by knowing, that it is kept at work by a horse, who, though an animated being, acts in our case but as a part of an engine, that is determined to go round, and who does neither intend to grind the corn, nor know that he grinds it.

AND in this place (though perhaps not the very fittest) I may question, with what congruity to their master's doctrine, the school-philosophers teach, that nature is the principle of motion in all the bodies they call natural. For, not to urge, that those great masses of sublunary matter, to which they give the name of elements, and the mixed bodies, that consist of them, are, by divers learned men, said to be moved to or from the center of the earth, by distinct internal principles, which they call gravity in the earth and water, and levity in the fire and air; and that there is ascribed also to every compounded body, that quality of the two, which belongs to the element, that predominates in it: not to urge this, I say, consider, that the celestial part of the world does so far exceed the sub-celestial in vastness, that there is scarce any comparison between them; and yet the generality of the Peripatetics, after

Aristotle, tells us, that the cœlestial globes of light, and the vast orbs they suppose them to be fixed in, are moved from west to east by the intelligences, that is, rational and separate beings, without whose conduct, they presume, that the motions of the heavens could not be so regular and durable, as we see they are: so that, in that part of the universe, which is incomparably vaster than the sublunary is, intelligences being the causes of motion, there is no recourse to be had to nature, as the true and internal principle of it.

AND here it may not, perhaps, be improper to declare somewhat more fully a point already touched upon; namely, that, if to know what is the general efficient cause of motion, can much contribute to the explication of particular phænomena, the hypothesis of those naturists, I now reason with, will have no considerable advantage, if any at all, of ours; which derives them from the primitive impulse given by God to matter, and from the mechanical affections of the greater and lesser portions of it. For it is all one to him, that would declare by what particular motion, as swift, slow, uniform, accelerated, direct, circular, parabolical, &c. this or that phænomenon is produced, to know, whether the motions of the parts of matter were originally impressed on them by nature, or immediately by God; unless it be, that He, being of infinitely perfect knowledge, may be, more probably than a creature, supposed to have at first produced in matter motions best accommodated to the phænomena, that were to be exhibited to the world. Nor do I see sufficient cause to grant, that nature herself (whatever she be) produces any motion *de novo*, but only, that she transfers and regulates that, which was communicated to matter at the beginning of things; (as we formerly noted, that in the human body, the rational soul or mind has no power to make new motions, but only to direct those of the spirits and of the grosser organs and instruments of voluntary motion). For, besides that many of the modern naturalists approve of the Cartesian opinion, that the same quantity of motion is always preserved in the whole mass of the mundane matter, that was communicated to it at first, though it be perpetually transferring it from one part to another; besides this, I say, I consider, that, if nature produces in these and those bodies motion, that were never before in beings; (unless much motion be annihilated, which is a thing as yet unproved) the quantity of motion in the universe must have for some thousands of years perpetually increased, and must continue to do so; which is a concession, that would much disorder the whole theory of local motion, and much perplex philosophers, instead of assisting them, in explicating the phænomena of bodies.

AND as for the effects of local motion in the parts of the universal matter, which effects make a great part of the phænomena of the world; after what I have formerly declared, you will not wonder to hear me confess, that, to me, the supposition of nature, whether men will have her an immaterial or corporeal substance, and either without knowledge or else endowed with understanding, doth not seem absolutely necessary, nor perhaps very useful, to make us comprehend how they are produced. The bodies of animals are divers of them little less curiously framed than men's, and most of them more exquisitely, than, for aught we know, the great inanimate mass of the corporeal world is; and yet, in the judgment of no mean naturalists, some of the mechanical philosophers, that deny cogitation, and even sense properly so called, to beasts, do, at least as intelligibly and plausibly, as those, that ascribe to them souls endowed with such faculties, as make them scarce more than gradually different from human-ones, explicate the phænomena, that are observed in them. And I know not, whether I may on this occasion add, that the Peripatetics themselves, especially the moderns, teach some things, whence one may argue, that the necessity of recurring to nature does not reach to so many things by far, as is by them supposed. For

the efformation (or framing) of the bodies of plants and animals, which are, by great odds, the finest pieces of workmanship to be met with among bodies, is ascribed not immediately to nature, but to the soul itself, which they will have to be the author of the organization of the body, and therefore call it the architect of its own mansion; which, they say, that it frames by an innate power and skill, that some call plastic, and to which others give other names. And unto the same soul, operating by her several functions, they attribute the concoction of aliments, the expulsion of excrements, the production of milk, semen, &c. the appetitive, loco-motive, and I know not how many other faculties, ascribed to living bodies. And, even in many inanimate ones, the noblest properties and operations are, by the same school-philosophers, attributed to what they call their substantial forms; since from these they derive the wonderful properties of the load-stone, the attractive faculty of amber and other electrics, and the medical virtues of gems and other mineral bodies, whether consistent or fluid.

BUT not to insist on this argument, because it is but *ad hominem* (as they speak), if we consider the thing itself, by a free examen of the pretended explanations, that the vulgar philosophers are wont, by recurring to nature, to give of the phænomena of the universe; we shall not easily look on those accounts, as meriting the name of explications. For to explicate a phænomenon, it is not enough to ascribe it to one general efficient, but we must intelligibly shew the particular manner, how that general cause produces the proposed effect. He must be a very dull inquirer, who, demanding an account of the phænomena of a watch, shall rest satisfied with being told, that it is an engine made by a watch-maker; though nothing be thereby declared of the structure and co-aptation of the spring, wheels, balance, and other parts of the engine, and the manner, how they act on one another, so as to co-operate to make the needle point out the true hour of the day. And (to improve to my present purpose an example formerly touched upon) as he, that knows the structure and other mechanical affections of a watch, will be able by them to explicate the phænomena of it, without supposing, that it has a soul or life to be the internal principle of its motions or operations; so he, that does not understand the mechanism of a watch, will never be enabled to give a rational account of the operations of it, by supposing, as those of *China* did, when the Jesuits first brought watches thither, that a watch is an European animal, or living body, and endowed with a soul. This comparison seems not ill to besit the occasion of propounding it; but to second it by another, that is more purely physical, when a person, unacquainted with the mathematics, admires to see, that the sun rises and sets in winter in some parts of the horizon, and in summer in others, distant enough from them; that the day, in the former season, is, by odds shorter, than in the latter, and sometimes (as some days before the middle of *March* and of *September*) the days are equal to the night; that the moon is sometimes seen in conjunction with the sun, and sometimes in opposition to him; and, between those two states, is every day variously illuminated; and that sometimes one of those planets, and sometimes another, suffers an eclipse; this person, I say, will be much assisted to understand, how these things are brought to pass, if he be taught the clear mathematical elements of astronomy: but if he be of a temper to reject these explications, as too defective, it is not like that it will satisfy him, to tell him after *Aristotle* and the schoolmen, that the orbs of the sun and moon, and other coelestial spheres, are moved by angels or intelligences; since to refer him to such general and undetermined causes, will little, or not at all, assist him to understand, how the recited phænomena are produced.

If it be here objected, that these examples are drawn from factitious, not from merely physical bodies; I shall return this brief answer, and desire, that it be applied not only to the two freshly mentioned examples, but to all of the like kind, that may be met with in this whole treatise, (near the beginning of which, had I remembered it, something to the same purpose should have had place): I say then in short, that divers of the instances we are speaking of are intended but for illustrations; and that others may be useful instances, if they should be no more than analogous ones: since examples, drawn from artificial bodies and things, may have both the advantage of being more clearly conceived by ordinary understandings, and that of being less obnoxious to be questioned in that particular, in which the comparison or correspondence consists. And I the less scruple to employ such examples, because *Aristotle* himself, and some of his more learned followers, make use of divers comparisons, drawn from the figures and other accidents of artificial things, to give an account of physical subjects, and even of the generation, corruption, and forms of natural bodies.

THIS advertisement premised, I pursue the discourse it interrupted, by adding, that thus we see that confirmed, which was formerly observed; namely, that though mechanical principles could not be satisfactorily employed for explaining the phenomena of our world, we must not therefore necessarily recur to, and acquiesce in that principle, that men call nature, since neither will that intelligibly explain them; but in that case, we should ingenuously confess, that we are yet at a loss, how they are performed; and that this ignorance proceeds, rather from the natural imperfection of our understandings, than from our not preferring nature (in the vulgar notion of it) to the mechanical principles, in the explication of the phaenomena of the universe. For whereas *Monsieur Des Cartes*, and other acute men, confidently teach, that there are scarce any of these phaenomena, that have been truly and intelligibly deduced from the principles peculiar to the Aristotelians and school philosophers; it will scarce be denied by any, that is acquainted with physico-mathematical disciplines, such as optics, astronomy, hydrostatics, and mechanics, more strictly so called, but that very many effects (whereof some have been handled in this present tract) are clearly explicable by mechanical principles; which, for that reason, *Aristotle* himself often employs in his *Quaestiones Mechanicae*, and elsewhere: so that, if because the corpuscularian principles cannot be satisfactorily made use of to account for all that happens among things corporeal, we must refuse to acquiesce in them; it is but just, that since a recourse to what is called nature is yet more dark and insufficient, at least, we must reject as well the latter as the former hypothesis, and endeavour to find some other preferable to both.

AND now, if it be demanded, what benefit may redound to a reader from the explications given in the foregoing seventh section? and in general, from the troublesome, as well as free inquiry, whereof they make a considerable part? I shall answer, that I am not quite out of hope, that the things hitherto discoursed may do some services both to natural philosophy and to religion.

AND as to the first of these; this tract may be of use to the cultivators of that science, by dissuading them from employing often, and without great need, in their philosophical discourses and writings, a term, (I mean nature) which, by reason of its great ambiguity, and the little or no care, which those, that use it, are wont to take, to distinguish its different acceptions, occasions both a great deal of darkness and confusedness in what men say and write about things corporeal; and a multitude of controversies, wherein really men do but wrangle about words, whilst they think they dispute of things; and perhaps would not differ at all, if they had the skill or

luck to express themselves clearly. Besides which service, the past discourse may do this other, to wean many from the fond conceit they cherish, that they understand or explicate a corporeal subject or a phenomenon, when they ascribe it to nature; for to do that, one needs not be a philosopher, since a country swain may easily do the same thing.

ON this occasion, I must not forbear to take notice, that the unskilful use of terms of far less extent and importance, and also less ambiguous, than the word nature is, has been, and still is, no small impediment to the progress of sound philosophy. For not only the greatest part both of physicians (though otherwise learned men) and of chymists; but the generality of physiologists too, have thought, that they have done their part, though not on all occasions, yet on very many, when they have referred an effect or a phenomenon to some such things as those, that are presumed to be real qualities; or are by some stiled natural powers, or are by others, by a more comprehensive and more usual name, (which therefore they here chiefly employ) called faculties; for each of which they are wont to form a name, fit for their purpose; though they do not intelligibly declare, what this faculty is, and in what manner the operations they ascribe to it, are performed by it. Thus the attractive faculty ascribed to a man, that is enabled by nature's (presumed) abhorrence of a vacuum, to suck up drink through a straw or pipe, has been for many ages acquiesced in, as the true cause of the ascension of that liquor in suction; of which nevertheless the modern philosophers, that have slighted explications derived merely from faculties, have assigned (as has been already declared) intelligible, and even mechanical causes. The power, that a load-stone has with one pole to attract (as they speak) the northern point of the mariner's needle, and with the other to drive it away, is looked upon as one of the noblest and most proper faculties of that admirable stone. And yet I elsewhere shew, how in a very small, indeed, but true and natural magnet, I have, by a bare, and sometimes invisible change of texture, given that extreme of the magnet, that before drew the southern point of the needle, the power to draw the northern, and to the opposite extreme, the power to drive it away; so much does even this wonderful attractive faculty, as it is called, depend upon the mechanical structure of the mineral, and its relation to other bodies, among which it is placed, especially the globe of the earth, and its magnetical effluvia.

BUT because in another paper I purposely discourse of what naturalists call faculties, I shall here content myself to note in general, that the term faculty may, indeed, be allowed of, if it be applied as a compendious form of speech, but not as denoting a real and distinct agent; since in reality the power or faculty of a thing is (at least) oftentimes but the matter of it, made operative by some of its mechanical modifications; [I say some, because the complex of all makes up its particular nature]. And with how little scruple soever men commonly speak of faculties, as supposing them to be distinct and active principles; yet this condition does not necessarily belong to them: for sometimes, if not frequently, the effect of what is reputed a natural power or faculty, is produced by the texture, figure, and, in a word, mechanical disposition of the agent, whereby it determines the action of a remoter agent to the produced effect. Thus in a clock, to make the balance vibrate, to point at the hour, to make, at set times, the hammer strike upon the bell, are but different effects of the weight or spring, that sets and keeps the engine in motion. And so a key may either acquire or lose its power of opening a door, (which, perhaps, some schoolmen would call its aperitive faculty) by a change, not made in itself, but in the locks it is applied to, or in the motion of the hand, that manages it. And lest it should be objected, that these instances are taken wholly from artificial bodies, I shall add,
that

that when a clear piece of native chryſtal has obtained, as it often does, a good priſmatical ſhape, and is, in a due poſition, expoſed to the ſun-beam, its figuration, by enabling it to refract and reflect thoſe beams after a certain manner, gives it a colorific faculty, whereby it is enabled to exhibit that wonderful and pleaſing variety of colours, that emulate, if not ſurpaſs, thoſe of the rain-bow. And ſo in a concave metalline looking-glaſs, though there ſeem to be many diſtinct faculties, ſuch as that of reflecting, inverting, magnifying divers objects, and melting, burning, &c. ſeveral bodies; yet all theſe powers are but the genuine conſequences of the figure, capacity and ſmoothneſs, which are mechanical affections of the matter of the ſpeculum. And indeed, if I judge aright, (though what I am going to ſay will ſeem a paradox) *yet many qualities of very many bodies are but laſting diſpoſitions to be thus or thus wrought upon by the action of external agents*, and alſo (perchance) to modify that action; as we ſee, that the power of making an eccho, that is obſerved in divers hollow places, is nothing but the mechanical diſpoſition their figure and reſiſtance gives them to reflect a ſound. And, to reſume the lately mentioned inſtance of a key, we may add, that, by bare poſition, either end of it, eſpecially if the key be long, may be made to acquire or loſe a tranſient magnetic faculty from the effluvia of that great magnet, the earth; and that alſo the ſame key may, in a few moments, acquire a durable magnetiſm, by a mechanical change received from the loadſtone, as is known to thoſe, that are any thing verſed in the philoſophy of that wonderful mineral.

AND to me it ſeems likely, that one main reaſon, why learned men have aſcribed ſuch inherent and active powers, as they call faculties, to ſo many bodies, is, becauſe that not being converſant enough with natural and artificial things, they did not duly perpend, how great a difference there may be between a body conſidered abſolutely, or by itſelf, and the ſame body conſidered in ſuch circumſtances, as it may be found in. For in ſome caſes a phyſical body may have ſtrange things juſtly aſcribed to it, though not as it is ſuch a body conſidered ſimply, or unassociated with other bodies; but as it is placed among congruous ones, and makes the principal or moſt operative part of a compounded body, or of the complex of bodies it is joined with, and which are of ſuch determinate ſtructures, as are convenient for the phænomena to be exhibited. This may be analogically ſeen in what happens to a ſpring; for if, being bent, it is held in one's hand, or crouded into a box, it is but a ſimple thing, that does only, by its expaſive endeavour, ſtrive to remove the bodies, that keep it compressed: but in a curious watch, it may, by virtue of the ſtructure of that engine, become the principle of I know not how many differing, and perhaps contrary, motions among the parts of it, and of many notable phænomena and effects exhibited or produced thereby. This reflection may perhaps be improved, if I here add, that, in many bodies, a fluid ſubſtance, determined to convenient motions, may be equivalent to an internal ſpring, eſpecially if it be aſſiſted by friendly external agents. This may be illuſtrated by conſidering, that if one, that plays ſkilfully on a flute, blow out of his mouth into the open air, he will but turn it into a vapid aerial ſtream; but if this wind duly paſs into the inſtrument, and be modified there by the muſician's fingers and ſkill, the ſimple ſtream of air may be formed into very various and melodious tunes. Thus gunpowder artificially tempered, though, if it be fired in the open air, it will give only a rude and ſudden flaſh, that preſently vaniſhes; yet, if it be ſkilfully diſpoſed of in rockets, and other well-contrived inſtruments, and then kindled, it will exhibit a great and pleaſing variety of ſhining bodies and phænomena, that are juſtly admired in the beſt ſort of artificial fire-works. A phyſical inſtance alſo, in favour of our analogical or vicarious ſprings (if I may ſo call them)

is afforded me by the bulbs of onions, and the roots of aloes, commonly called *semper-vive*, and some other vegetables, which in the spring being exposed to the air, the juices and spirits contained in them, will be so agitated by the warmth of that season, and so modified by the particular structure of the more firm parts, that, though neither earth nor rain co-operate, they will shoot forth green stalks or leaves for many weeks together, as if they were planted in a good soil; (though the matter of these green productions be furnished by the radical parts themselves, as may be argued both from the manifest diminution of the bulb in bigness, and the great and gradual decrement in weight, that I observed in making experiments of this kind. And so also the air, which is an external fluid, concurring with the juices and spirits of divers insects and other cold animals, may both be put into motion, and have that motion so determined by their organization, as to recover in the spring or summer, as it were, a new life, after they have lain moveless, and like dead things, all the winter; as we see in flies, that, in a hot air, quickly recover motion and sense, after having lost both, for perhaps many months. And the like change may be far more suddenly observed in them, in the warmer seasons of the air, when the air is drawn from them by the pneumatic pump, and afterwards permitted to enliven them again. And to give another instance, that may possibly please better, (because, as it is purely physical, so it is simple and very conspicuous), though that, which the sun-beams are wont primarily to produce be but light, and perhaps heat; yet, falling in a due manner upon a rorid cloud, they form there the figure of a vast bow, and, being variously reflected and refracted, adorn it with the several colours men admire in the rainbow.

BUT I must not farther prosecute an observation, that I mentioned but occasionally, as an instance, whereby to shew, that the advancement of solid philosophy may be much hindered by men's custom of assigning, as true causes of physical effects, imaginary things or perhaps arbitrary names; among which none seems to have had a more malevolent influence upon physiology, than the term *nature*, none having been so frequently and confidently used, or employed to so many differing purposes. And therefore, though I would not totally forbid the use of the word *nature*, nor of expressions a-kin to it, in popular discourses, or even in some philosophical ones, where accurateness is not required, or ambiguity is prevented by the context; nor (to dispatch) where it may be employed as a compendious form of speech, without danger to truth, or prejudice to sound philosophy (in which cases I myself forbear not the use of it); yet, I hope, our free inquiry may (somewhat at least) conduce to the more skilful indagation and happy discovery of physical truths, if it can persuade men to make use less frequently, and with more circumspection, of so ambiguous, and so often abused, a term as *nature*; and cease to presume, that a man has well performed the part of a true physiologer; till he have circumstantially or particularly deduced the *phænomenon* he considers, by intelligible ways, from intelligible principles: which he will be constantly put in mind of doing, or discover, that he hath not done it, if, by forbearing general and ambiguous terms and words, he endeavours to explain things by expressions, that are clear to all attentive readers furnished with an ordinary measure of understanding and reason. And this perspicuous way of philosophizing should be not a little recommended to ingenious men, by the valuable discoveries, which those, that have employed it, in their researches and explications of difficult things, have in this inquisitive age happily made, not only about the various *phænomena* commonly referred to the *fuga vacui*, but in the hydrostatics, optics, anatomy, botanics, and divers other parts of real learning, that I cannot now stay to enumerate. And thus much it may possibly be sufficient to have said about the service our doctrine may do natural philosophy.

As for religion, if what I have formerly said in favour of it be duly considered and applied, the past discourse will not appear unfriendly, nor perhaps useless, to it. And therefore, if I do here abridge what I have there said, and add to it some considerations, that were fit to be reserved for this place; I hope the doctrine we have proposed may appear fit to do it a threefold service.

I. AND in the first place, our doctrine may keep many, that were wont, or are inclined, to have an excessive veneration for what they call nature, from running, or being seduced, into those extravagant and sacrilegious errors, that have been upon plausible pretences embraced not only by many of the old heathen philosophers, but by divers modern professors of Christianity, who have of late revived, under new names and dresses, the impious errors of the Gentiles. This I venture to say, because many of the heathen writers, as hath been shewn in the fourth section, acknowledged indeed a God (as these also own they do), but meant such a God, as they often too little discriminated from matter, and even from the (*a*) world, and as is very differing from the true one adored by Christians and Jews: for ours is a God, first, infinitely perfect; and then secondly, by consequence, both incorporeal and too excellent to be so united to matter, as to animate it like the heathen's mundane soul; or to become to any body a soul properly so called; and thirdly, incapable of being divided, and having either human souls or other beings, as it were, torn or carved out, or otherwise separated from him, so as to be truly parts or portions of his own substance.

(*b*) Whereas, the idolaters and infidels I speak of conceived, under the name of God, a being, about which they dogmatically entertained conceptions, which, though different from one another, are much more so from the truth.

For first, most of them thought their God to be purely corporeal, as, besides what *Diogenes Laertius* and others relate, I remember *Origen* doth in several places affirm.

(*c*) *Præp.* If you will believe (*c*) *Eusebius*, the ancient Ægyptian theologers not only affirmed
l. iii. c. 4. the sun, moon, and stars, to be gods, but denied incorporeal substances, or invisible natures, to have framed the world, but only the sun, that is discoverable to our eyes.

And this corporeity of God seems manifestly to be the opinion of Mr. *Hobbes* and his genuine disciples, to divers of whose principles and dogmata it is as congruous, as it is repugnant to religion. But secondly, there are others, that allowed a soul of the world, which was a rational and provident being, together with the corporeal part of the universe, especially heaven, (which, I remember, *Aristotle* himself styles a

(*d*) *De* divine body, (or, as some render his expressions, the body of God): but withal,
Cælo l. ii. they held, that this being did properly inform this great mass of the universe, and so
c. 3.

(*a*) Thus the Stoicks, in *Laertius*, describe the world thus, *Mundus est, qui constat ex cælo & terra, atque ex illorum naturis; sive qui constat ex diis & hominibus, iisque rebus, quæ horum gratia conditæ sunt.* And of *Chrysippus*, one of the patriarchs of that sect, the same † historian in the same book says, *Purissimum dixit ac liquidissimum æthera, quem etiam primum asserunt Stoici esse deum, sensibiliter veluti infusum esse per ea, quæ sunt in aere, per cunctas animantes & arbores per terram autem ipsam secundum halitum.* To which agrees not only that noted passage of *Virgil*, *Principio Cælum*, &c. — but another, which I somewhat wonder learned men should read with no more reflexion; since he there gives the sky the very title of the high God: *Tum pater omnipotens sæcundis imbribus æther, &c.*

† *Diog.*
Laert. l. vii.
in vita
Zenon.

(*b*) The error here rejected, was the opinion of many of the heathen philosophers, and particularly of the Stoical sect; of whose author * *Laertius* says, *De divina substantia Zeno ait mundum totum atque cælum.* And several ethnic philosophers, even after the light of the gospel began to shine in the world, adopted the argument of the elder Stoicks, who inferred the world to be animated and rational from the nature of the human soul, which they thought a portion of the intelligent part of the world, that some of them confounded with the Deity. For the Stoicks (in *Laertius*) affirm, *Mundum esse animale & rationale & animatum (ἐν-ψυχον) & intelligibile.* And it is added, *Mundum animatum esse, inde manifestum est, quod anima nostra inde veluti avulsa sit.* Thus *Seneca*, *Quid est autem cur non existimes, in eo divini aliquid existere, quæ Dei pars est?* So *Plutarch*, speaking of the soul, *Non opus solum Dei, sed & pars est; neque ab ipso, sed ex ipso nata est.* And *Epictetus*, *Animæ ita alligatæ & conjunctæ Deo sunt, ut partem ejus sint.*

* In Vita
Zenonis.
De Vitis
Phil. l. vii.
Epist. 92.
Plutarch.
in Quest.
Plat.
Dissert. 1.
c. 14.

was,

was, indeed, a mundane soul. And though some of our late infidels (formerly pointed at in this treatise) pretend to be great discoverers of new light in this affair; yet, as far as I am informed of their doctrine, it has much affinity with, and is little or not at all better than, that which I formerly noted out of *Lactantius* to have been asserted by the Stoics, and the doctrine, which is expressed by *Maximus* (a Pagan) to *St. Austin*. *Equidem unicum esse Deum summum atque magnificum, quis tam demens, tam mente captus, ut neget esse certissimum? Hujus nos virtutes per mundanum opus diffusas multis vocabulis invocamus, quoniam nomen ejus cuncti proprium ignoremus.* Or by that famous and learned Roman, *Varro*, who is cited by *St. Austin*, to have said, *Deum se arbitrari animam mundi, & hunc ipsum mundum esse Deum: sed sicut hominem sapientem, cum sit ex animo & corpore, tamen ab animo dicimus sapientem; ita mundum Deum dici ab animo, cum sit ex animo & corpore.* De Civit. Dei, l. vii. c. 6.

THE doctrine, by us proposed, may, it is hoped, much conduce to justify some remarkable proceedings of Divine Providence against those cavillers, that boldly censure it, upon the account of some things, that they judge to be physical irregularities, (for moral ones concern not this discourse) such as monsters, earthquakes, floods, eruptions of volcanos, famines, &c. For, according to our doctrine,

I. GOD is a most free agent, and created the world, not out of necessity, but voluntarily, having framed it, as He pleased and thought fit, at the beginning of things, when there was no substance but Himself, and consequently no creature, to which He could be obliged, or by which He could be limited.

II. GOD having an understanding infinitely superior to that of man, in extent, clearness, and other excellencies, He may rationally be supposed to have framed so great and admirable an automaton as the world, and the subordinate engines comprized in it, for several ends and purposes, some of them relating chiefly to his corporeal, and other to his rational creatures; of which ends He hath vouchsafed to make some discoverable by our dim reason, but others are probably not to be penetrated by it, but lie concealed in the deep abyss of his unfathomable wisdom.

III. IT seems not incongruous to conceive, that this most excellent and glorious Being thought fit to order things so, that both his works and actions might bear some signatures, and, as it were, badges of his attributes, and especially to stamp upon his corporeal works some tokens or impresses, discernible by human intellects, of his divine wisdom; an attribute, that may advantageously disclose itself to us men, by producing a vast multitude of things, from as few, and as simple, principles, and in as uniform a way, as, with congruity to his other attributes, is possible.

IV. ACCORDING to this supposition, it seems, that it became the divine Author of the universe to give it such a structure, and such powers, and to establish among its parts such general and constant laws, as best suited with his purposes in creating the world; and to give these catholic laws, and particular parts or bodies, such subordinations to one another, and such references to the original fabric of the grand system of the world, that, on all particular occasions, the welfare of inferior or private portions of it, should be only so far provided for, as their welfare is consistent with the general laws settled by God in the universe, and with such of those ends, that He proposed to Himself in framing it, as are more considerable, than the welfare of those particular creatures.

UPON these grounds, if we set aside the consideration of miracles, as things supernatural, and of those instances, wherein the providence of the great Rector of the universe, and human affairs, is pleased peculiarly to interpose; it may be rationally said, that God, having an infinite understanding, to which all things are at once in a manner present, did, by virtue of it, clearly discern, what would happen, in conse-

quence of the laws by Him established, in all the possible combinations of them, and in all the junctures of circumstances, wherein the creatures concerned in them may be found. And, that having, when all these things were in his prospect, settled among his corporeal works general and standing laws of motion suited to his most wise ends, it seems very congruous to his wisdom, to prefer (unless in the newly excepted cases) catholic laws, and higher ends, before subordinate ones, and uniformity in his conduct before making changes in it according to every sort of particular emergencies: and consequently, not to recede from the general laws He at first most wisely established, to comply with the appetites or the needs of particular creatures, or to prevent some seeming irregularities (such as earthquakes, floods, famines, &c.) incommodious to them, which are no other, than such, as He foresaw would happen (as the eclipses of the sun and moon from time to time, the falling of showers upon the sea and sandy deserts, and the like must do, by virtue of the original disposition of things) and thought fit to ordain, or to permit, as not unsuitable to some or other of those wise ends, which He may have in his all-pervading view, who, either as the Maker and Upholder of the universe, or as the Sovereign Rector of his rational creatures, may have ends, whether physical, moral, or political, (if I may be allowed so to distinguish and name them); divers of which, for aught we can tell, or should presume, are known only to Himself: whence we may argue, that several phænomena, which seem to us anomalous, may be very congruous or conducive to those secret ends, and therefore are unfit to be censured by us dim-sighted mortals.

AND, indeed, the admirable wisdom and skill, that, in some conspicuous instances, the divine Opificer has displayed in the fitting of things for such ends and uses, for which (among other purposes) He may rationally be supposed to have designed them, may justly persuade us, that his skill would not appear inferior in reference to the rest also of his corporeal works, if we could as well in these, as in those, discern their particular final causes. As if we suppose an excellent letter about several subjects, and to different purposes, whereof some parts were written in plain characters, others in cyphers, besides a third sort of clauses, wherein both kinds of writing were variously mixed, to be heedfully perused by a very intelligent person; if he finds, that those passages, that he can understand, are excellently suited to the scopes, that appear to be intended in them, it is rational as well as equitable in him to conclude, that the passages or clauses of the third sort, if any of them seem to be insignificant, or even to make an incongruous sense, do it but because of the illegible words; and that both these passages, and those written altogether in cyphers, would be found no less worthy of the excellent * writer, than the plainest parts of the epistle, if the particular purposes, they were designed for, were as clearly discernable by the reader. And perhaps you will allow me to add, that by this way of ordering things so, that, in some of God's works, the ends or uses may be manifest, and the exquisite fitness of the means may be conspicuous; [as the eye is manifestly made for seeing, and the parts it consists of admirably fitted to make it an excellent organ of vision] and in other, the ends designed seem to be beyond our reach; by this way (I say) of managing things, the most wise Author of them does both gratify our understandings, and make us sensible of the imperfection of them.

If the representation now made of providence serve (as I hope it may) to resolve some scruples about it, I know you will not think it useless to religion. And though I should miss of my aim in it, yet since I do not dogmatize in what I propose about it, but freely submit my thoughts to better judgments; I hope my well-meant endeavours will be, as well as the unsuccessful ones of abler pens have been, excused by the scarce superable difficulty of the subject. However, what I have proposed about Providence, being

* See the Discourse of Final Causes.

being written, rather to do a service to theology, than as necessary to justify a dissatisfaction with the received notion of nature, that was grounded mainly upon philosophical objections; I hope our free inquiry may, though this second use of it should be quite laid aside, be thought not unserviceable to religion; since the first use of it (above delivered) does not depend on my notions about providence, no more than the third, which my prolixity about the former makes it fit I should in few words dispatch.

III. THE last then, but not the least, service, I hope, our doctrine may do religion, is, that it may induce men to pay their admiration, their praises, and their thanks, directly to God himself, who is the true and only Creator of the sun, moon, earth, and those other creatures, that men are wont to call the works of nature. And in this way of expressing their veneration of the true God, (who in the holy scripture styles himself a *jealous God*, *Exod. xx. 5.*) and their gratitude to Him, they are warranted by the examples of the ancient people of God, the *Israelites*, and not only by the inspired persons of the *Old Testament*, but by the promulgators of the *New Testament*, and even by the celestial spirits; who, in the last book of it, are introduced praising and thanking God himself for his mundane works, without taking any notice of his pretended vicegerent, nature. Rev. iv. 2.

The CONCLUSION.

AND now, dear *Eleutherius*, you have the whole bundle of those papers, that I found and tacked together, (for they are not all, that I have written) touching my free inquiry into the received notion of nature; at the close of which essay, I must crave leave to represent two or three things about it.

I. SINCE this treatise pretends to be but an inquiry, I hope that any discourses or expressions, that you have found dogmatically delivered, about questions of great moment or difficulty, will be interpreted with congruity to the title and avowed scope of this treatise; and that so favourable a reader, as *Eleutherius*, will consider, that it was very difficult, in the heat of discourse, never to forget the reserves, that the title may suggest, especially since, on divers occasions, I could not have spoken with those reserves, without much enervating my discourse, and being, by restrictions and other cautious expressions, tedious or troublesome to you. But this, as I lately intimated, is to be understood of things of great moment or difficulty; for otherwise, there are divers notions, suppositions, and explanations, in the vulgarly received doctrine of nature, and her phænomena, which I take to be either so precarious, or so unintelligible, or so incongruous, or so insufficient, that I scruple not to own, that I am dissatisfied with them, and reject them.

2. THOUGH, upon a transient view of these papers, I find, that several parcels, that came first into my hands, having been laid and fastened together (to keep them from being lost, as others had already been) before the others were lighted on, some of them will be met with in places, that are not the most proper for them; yet haste and sickness made me rather venture on your good nature for the pardon of a venial fault, than put myself to the trouble of altering the order of these papers, and substituting new transitions and connections, in the room of those, with which I formerly made up the chasms and incoherency of the tract you now receive. And if the notions and reasoning be themselves solid, they will not need the assistance of an exact method to obtain the assent of so discerning a reader, as they are presented to; upon the score of whose benignity it is hoped, that the former advertisement may likewise pass for an excuse, if the same things, for substance, be found more than once in a tract
written

written at very distant times, and in very differing circumstances. For, besides that such seeming repetitions will not (if I be not mistaken) frequently occur, and will, for the most part, be found, by being variously expressed, to elucidate or strengthen the thought or argument they belong to; and besides that the novelty and difficulty of some points may have made it needful, not only to display, but to inculcate them; besides these things, I say, it is very possible, that the same notion may serve to explicate or prove several truths, and therefore may, without impertinency, be made use of in more than one part of our treatise. And if our inquiry shall be thought worthy to be transcribed, and presented to you a second time, after I shall have reviewed it, and heard objections against it, and considered the things, that either you, or I myself, may find fault with in it; it is very possible, that (if God grant me life and leisure) this tract, which, in its present dress, I desire you would look on but as an apparatus towards a more full and orderly treatise, may appear before you in a less unaccurate method; and that my second thoughts may prove more correct, more mature, or better backed and fortified, than my first.

3. THE subject of my inquiry being of great extent, as well as consequence, it obliged me to consider, and treat of many things, (as philosophical, medical, theological, &c.) and, among them, of divers, that are not at all of easy speculation; and I found it the more difficult to handle them well, because the attempt I have ventured upon being new, and to be prosecuted by discourse, many of them opposite to the general sentiments of mankind, I was not to expect much assistance from any thing, but truth and reason. And therefore, as I cannot presume not to need your indulgence, so I cannot despair of obtaining it, if in this my first essay, upon a variety of difficult points, I have not always hit the mark, and as happily found the truth as sincerely sought it. But if you shall (which it is very probable you will) find, that I have fallen into some errors, it will be but one trouble for you, to make me discern them, and forsake them, (especially any, wherein religion may be concerned) which I have, by way of prævision, made it the more easy for myself to do; because (if my style have not wronged my intention) I have written this discourse, rather like a doubting seeker of truth, than a man confident that he has found it.

THE
MARTYRDOM
OF
THEODORA
AND OF
DIDYMUS.

Such an ACCOUNT of the following BOOK, sent with it to a
FRIEND, as may serve instead of a PREFACE.

TO convince you, Sir, how much more I am concerned to have you think I can obey well, than write well, I venture to send you the account, (as imperfect and unpolished as it is) that you are pleased to command of the last hours of *Theodora*; but I must beg your leave to accompany it with another account (though but a short one) how I came to meddle with this subject, and why what I present you about it, is so much maimed, and has no more uniformity.

HAVING had occasion many years ago to turn over a martyrology, and some other books, that related to the sufferings of the primitive Christians, I chanced to light on those of a virgin, who, though (to my wonder) she was left unnamed by the other writers, that mentioned her, seemed plainly to be the same, that is by one of them expressly called *Theodora*. I own, I was not a little affected, at the reading of such moving and uncommon adventures as hers, and finding her story to be related by the author, that named both her and her lover, not only very succinctly and imperfectly, but very dully too; I found myself tempted so to enlarge this story, as that it might be contrived into a somewhat voluminous romance: but, upon second thoughts, it appeared incongruous to turn a martyr into a nymph or an amazon; and I considered too, that (to omit what else might be objected against that sort of composures) as true pearls are cordials and antidotes, which counterfeit ones, how fine soever they may appear, are not; so true examples do arm and fortify the mind far more efficaciously, than imaginary or fictitious ones can do; and the fabulous labours of *Hercules*, and exploits of *Arthur of Britain*, will never make men aspire to heroic virtue half so powerfully, as the real examples of courage and gallantry afforded by *Jonathan*, *Cesar*, or the *Black Prince*. But yet, thinking it great pity, that so shining a virtue as *Theodora's* should prove exemplary, but to her own time, and to one city; and remembering, that soon after the age, which she ennobled, it was counted among the primitive Christians an act of piety, to build fair monuments, upon the formerly abject graves of the martyrs, to repay, by honours due to their memories, the indignities and disgraces they had suffered in their persons; I thought fit to try, if I could rescue

from more unskilful hands than even mine a story, that abundantly deserved to be well told.

BUT, upon further thoughts, I soon foresaw, that this task was not more worthy to be undertaken, than it would prove difficult to be well performed: for the martyr-ologist, having allowed scarce one whole page to a relation that perhaps merited a volume, had left so many chafins, and so many necessary things unmentioned, that I plainly perceived I wanted a far greater number of circumstances, than that he had supplied me with, to make up so maimed a story tolerably compleat. And as the relation denied me matter enough to work upon, so the nature of the subject refused most of those embellishments, which in other themes, where young gallants and fair ladies are the chief actors, are wont to supply the deficiencies of the matter. Besides, my task was not near so easy, as it would have been, if I had been only to recite the intrigues of an amour, with the liberty to feign surprizing adventures to adorn the historical part of the account, and to make a lover speak as passionately as I could, and his mistress as kindly, as the indulgentest laws of decency would permit. But I was to introduce a Christian and pious lover, who was to contain the expressions of his flame within the narrow bounds of his religion; and a virgin, who, being as modest and discreet as handsome, and as devout as either, was to own an high esteem for an excellent lover, and an uncommon gratitude to a transcendent benefactor, without intrenching either upon her virtue, or her reservedness. And I perceived the difficulty of my task would be encreased, by that of reconciling *Theodora's* scrupulousness to the humours of some young persons of quality of either sex, who were earnest to engage my pen on this occasion, and would expect, that I should make *Theodora* more kind, than I thought her great piety and strict modesty would permit. But for all this, the esteem I had for the fair martyr's excellencies, and the compliance I had for those, that desired to receive an account of so rare a person's actions and sufferings, made me resolve to try what I could do; which I adventured upon with the less reluctancy, because, though I esteemed it a kind of profaneness to transform a piece of martyrology into a romance, yet I thought it allowable enough, where a narrative was written so concisely, and left so imperfect, as that I had to descant upon, to make such supplements of circumstances, as were not improbable in the nature of the thing, and were little less than necessary to the clearness and entireness of the story, and the decent connection of the parts it should consist of. I supposed too, that I need not scruple to lend speeches to the persons I brought upon the stage, provided they were suitable to the speakers, and occasions; since I was warranted by the examples of *Livy*, *Plutarch*, and other grave and judicious historians, who make no scruple to give us set orations of their own framing, and sometimes put them into the mouths of generals at the head of their armies, just going to give battle; though at such times the hurry and distraction, that both they and their auditors must be in, must make it very unlikely, either that they should make elaborate speeches, or their hearers mind and remember them well enough to repeat them to the historians.

ENCOURAGED by these liberties, which I thought I might justly allow myself, I drew up, as well as I could, what you have been told I wrote about *Theodora*. This I thought fit to divide into two parts, in the first whereof (which was less remote from being romantic) I gave somewhat at large the characters of them both; I mentioned the rise and progress of *Didymus's* love; the degeneracy of the then Christians, which provoked Divine Providence to expose them to a very bloody persecution: I declared, how *Theodora*, being involved in it, was brought before the president of *Antioch*; how she resolutely owned her religion before him, answered his arguments, and resisted both his promises and his menaces; how thereupon the judge doomed her

her either to sacrifice, or to be prostituted in the public stews; how she, after an eager debate in her own mind, refusing to offer sacrifice, was (notwithstanding her silence) led away to the infamous place; how, being shut up there alone in a room, she employed the little time, that was granted her, to consider, whether she would yet burn incense to the Roman idols, in fervent prayer to the true God, for a rescue of her purity, not her life; in order whereunto, she designed, and hoped, by resistance and contumelies, to provoke her first assailant to become her murderer, rather than her ravisher.

THESE were the chief contents of the first book. Those of the second were more historical, and consisted of an account of the last hours of her life, and particularly of those sufferings, that ended in her and *Didymus's* glorious martyrdom. This piece, having been perused by those for whose sake I wrote it, was so fortunate, that it having, without my leave, been ventured into several hands, as a book of a nameless and unknown author, it was lucky enough to be, by some indulgent readers, attributed to one, and by some to another, of the two persons, that were at that time counted the best writers of disguised histories. But among the many hands it passed through, it seems it fell into some, out of which a great part of the loose sheets (which were not bound in a book, but only tacked together) were not to be retrieved: whether it were by the negligence, or the contempt, that some had of so unpolished a work; or whether there were some fatality in the business, that *Theodora's* sufferings should outlive her, and her story be as ill used as her person had been. This loss (if it can deserve that name) I did not much regret, since I intended not to make the lost papers public, and had received much greater approbation and thanks, than they merited, from the particular persons they were designed for. But after I had for many years worn out, not only the sense, but the memory of this loss, it was made more troublesome to me, than ever it was at first, by the earnest solicitations of some eminent persons, that had a great power over me, and some of them the repute of great judges of this kind of compositions: for having seen several sheets, that I accidentally lighted on in tumbling over some long neglected papers, they obliged me to cause those old rude sheets to be transcribed; and though almost all the first book was wanting, (upon which account I could not be removed from my resolution not to trouble myself about it) yet there was so much of the second book, but in parts no way coherent, little by little retrieved, that a pretence was afforded to press me to repair those breaches, and restore out of my memory, or otherwise, a piece, which they would needs persuade me might do some good, by rendering virtue amiable, and recommending piety to a sort of readers, that are much more affected by shining examples, and pathetical expressions, than by dry precepts, and grave discourses.

If some of your more scrupulous friends shall object, that I have mentioned *Theodora's* beauty more often and advantageously, and represented her lover's passion more pathetically, than the subject of the story exacted, and the truth required in history would warrant; I shall not altogether deny the charge, being rather content to have it thought, that a youthful and heated fancy transported my pen somewhat beyond the narrow bounds of history, than that so pious a person, as *Didymus*, did not keep both his flame, and the expressions of it, within the limits of reason and religion. But though I pretend not to justify all that has been said in the strain of an encomiast, or a lover; yet I hope, that I may much extenuate, if not excuse it, by representing such things as these.

THAT I have been careful, that *Theodora* should not be made to do any thing, that, the great obligations she had to her rescuer considered, do intrench either upon her piety, or her virtue, or so much as upon her reservedness.

THAT as for *Didymus*, I might say, that probably he thought those celebrations, that would have been flattery to another lady, were but justice to a person so extraordinary, and so accomplished, as his mistress; and that he thought it allowable, not to suppress the chaste effects of a passion, that has not only been incident to heroes, but perhaps helped to make them such. But I will rather say, that those only are like to find much fault with his expressions, who consider not, how free they are from any degree of prophaneness or immodesty; and who are not accustomed to the reading of stories, where lovers are introduced, and made to praise and compliment in a far more bold and romantic way, than I allowed myself in the following paper: in which, all the deference, wherewith *Irene* as well as *Didymus* treat *Theodora*, may be accounted for by this; that I remembered to have, in some author or other, found mention made of a person about *Dioclesian's* time, whom I took for our martyr, that was intimated to be of high quality, if not a princess, which title I had without scruple given her, if I had been half as sure, that she was a princess, as that she deserved to be one.

THAT perhaps I was not unwilling, both to shew the persons I wrote for, that one might have glittering ideas of beauty, without being dazzled by them; and also to convince them, that high compliments, and passionate expressions, are no certain marks of his being really smitten (to speak in a lover's phrase) that can employ them; since I retained my wonted freedom of mind, while I was writing, and presented them, by the mouth of *Didymus*, but what fancy, not passion, indited.

AND lastly, I was induced to allow myself a more fashionable stile, than would perhaps be suitable to a meer sermon, or book of divinity; because I feared, that the youthful persons of quality of both sexes, that I was chiefly to regard, would scarce be sufficiently affected by unfortunate virtue, if the interweaving of passages relating to beauty and love did not help to make the tragical story delightful, and the excellent sufferers piety amiable.

IF it be objected, that in some of the discourses of the two martyrs there are passages, that argue more knowledge, than is likely to have been found in lay persons no elder than they; I answer, that such discourses indeed were somewhat strange, if they were ascribed to a young gallant, and a younger lady, of our degenerate times, wherein so many persons of that sort make diversion their grand business, and, having as little leisure, as concern, to mind any thing, but their pleasures and petty interests, think it their privilege to know little of religion, and leave to meaner people the study of things serious and useful. But though among this sort of people it were so difficult to find many, that would emulate such knowledge and virtue, as shined in *Theodora*, that I fear they would not so much as believe them; yet among better qualified judges the lately proposed objection will be of no great force, if it be considered, that *Didymus* and *Theodora* lived in the primitive and devout times of the church, and in the *Roman* empire, when the Christian religion was as diligently taught by excellent divines, as frequently opposed by arguments, and violently assaulted by persecutions. Upon which scores the zealous candidates of martyrdom, many of which obtained the crown of it even in their greener age, were early and skilfully instructed in the truths of their own religion, and furnished with good arguments, both to defend it, and confute the erroneous opinions and impious worships of their heathen adversaries: nor is it any wonder, that they should think that religion worth studying, that they thought worth dying for. I will not here examine, whether the ignorance wont to be imputed to women be their fault, or that of their accusers; and whether it is any natural want of capacity, or rather want of instruction, that keeps most of them from knowledge, though this regards not sexes. But without inquiry, whether it be not
our

our interest, or our envy, that makes women what we are wont to decry them for being; I shall not scruple to own, that I have sometimes had the honour to converse with ladies, that convinced me, that, to attain a great proficiency of knowledge, it is not necessary to be a doctor of divinity, or so much as a man, since they discoursed of divine things with no less wit than piety. And to return to our martyr, if we may judge by the effects, we may reasonably suppose, that our virgin's parents not only thought it their duty, but took much pleasure, to cultivate so excellent and promising a subject as their fair daughter; since great advantages of nature, and general grace, should rather invite, than excuse, improvements by education; as even the garden of *Eden*, though an admirably fertile soil, and planted by God's own hands, was not so left to itself, but that *Adam* was appointed to dress it, and to keep it. And if the discourses of our martyrs are sometimes less short, than they might have been made; I hope it may be some excuse, that I was not unwilling, to lay hold now and then of the rises afforded me by some occasions, to shew, that romantic subjects are not, as too many persons of quality think them, the only ones, that may be treated of in a gentleman-like stile; and that even some noble questions in divinity, and some of the severer dictates of the Christian morals, may be discoursed of, without the harshness of the school terms, or the downright plainness of some better meant, than penned, books of theology and devotion.

It is like, Sir, you will think it strange, that I make so pious a person, as *Theodora*, offer her breast to *Didymus's* sword, and, by soliciting him to kill her, tempt him to an action, which would make her guilty of a murder, and make him greatly accessory to it. But possibly her action would not appear very strange, if we were not too inclinable to estimate the affairs of past times, and remote regions, by the opinions and customs of our own age and countries. For whatever we now justly think of the sinfulness of destroying a man's self, whether immediately or otherwise, yet I must not deny, but that divers of the ancient Christians thought it not criminal, when it was necessary for the preservation of chastity: and, if I much misremember not, *St. Jerom* himself, where he speaks of the unlawfulness of self-destroying, intimates, that he excepts the case of an inevitable danger of a rape. But my chief answer is, that, having found the virgin martyr's proposal expressly delivered by the author I was to follow, I judged it the part of an historian not to suppress it; which I acknowledge I the rather declined to do, because *Theodora's* offer was a noble evincement both of her gratitude and her generosity. And therefore, instead of omitting so considerable an action of hers, I chose rather to set my thoughts a-work, to find a plausible colour for it; which whether I have happily done, by supplying her with the example of a prophet, who, though he would not cast himself into the sea, yet solicited others to cast him, (and that having first bound him) I must leave you to judge.

I FREELY confess, Sir, that, if the following piece had been written by one, that I were fond of censuring, I could myself find enough in it to criticise upon; and should object against it, besides the want of uniformity throughout, that, if judged of by the strict rules of art, it ought to pass for an irregular piece. And therefore I shall not wonder, if nicer critics, and more versed in exquisite compositions, than I pretend to be, shall find fault with this artless one of mine. But the reception, that the following papers met with, from the persons, for whom they were chiefly written, affords me the consolation derivable from the ingenious saying of that excellent wit, who declared, he had rather the dishes served up at his treat should please the guests, than the cooks. And I might say too, that some of the passages, that may meet with censure, would perhaps escape it, if in writing this book many years

ago, I had not had some aims, that I then thought more fit to be pursued, than I now do to be declared. Yet I will not here dissemble, that I know it may be thought by some, that this paper should have consisted less of conversations, and more of narratives. But I chose the way of writing I have employed, partly because the authors I met with furnished me with so very few matters of fact, that, if I would have confined myself to relations, I must have comprized this piece in a very few pages, and have finished it presently after I had begun it; and partly too (and indeed much more) because (as I lately began to intimate) my chief design was not so much to perform the office of a meer historian, as to take rises, from the several circumstances I should relate, to convey unperceivedly into the minds of those young persons of quality, for whom I wrote, sentiments of true piety and virtue: and these I thought would not so happily gain admittance and entertainment, if they were presented in a scholar-like discourse, or a professed book of devotion, as when they were taken, not from common places, but from the nature of the things and persons introduced, and without formality instilled by the occasional discourses of a young gentleman and fair lady, for whom the beauty and the merit ascribed to the speakers had given the hearers a great esteem and kindness. And I shall not scruple to own, that I, who value time above most other things, did not think it worth the expence of mine, to give myself the trouble of writing a book, only to give others a divertisement in reading it. And whilst I was conversing with such excellent company, as our noble martyrs, and meditating on such serious subjects as are death, and the worth of that heavenly religion, for whose sake they despised it; I found myself incited, and thought myself obliged, to aim less at the pleasing of some few nice exactors of regularity, than to possess many readers with high and noble sentiments of the Christian religion, and the sublime dictates of it; and thereby both elevate their minds to a generous contempt of all they can lose and suffer for it, and fill them with bright ideas of heroic virtue, and of the much brighter glories, that will crown it. By such reflections I was induced not to omit some passages, that seemed likely to further the main ends I pursued, though I foresaw, that perhaps some rigid judges would say, that they might have been spared. For as I writ not a romance, wherein authors are wont to aim no higher, than to delight the delicate readers, and escape the critical ones, by making their composures diverting and regular; so I presumed, that to employ a more useful, though less fashionable way of writing, was allowable for me, who ought to endeavour, in such a piece as this, rather to propose patterns of virtue, than models of skill or eloquence; and to think it more successful, if the readers shall, upon perusing it, imitate our excellent martyrs piety, than if they should only applaud their history; which both as to stile and reasonings is freely submitted to your judgment by,

S I R,

Your most, &c.

The MARTYRDOM of THEODORA.

B O O K II.

C H A P. I.

THOUGH it may seem ill-natured to leave the chaste *Theodora* in so deplorable a condition, yet it is requisite to do so for a while, that we may learn what was attempted to rescue her out of it.

It

It is not to be doubted, but that *Didymus* was not long kept a stranger to the barbarous usage she had suffered. That of so illustrious a lady could not but make a great noise, and reach a multitude of ears, and especially those of so concerned a person as *Didymus*; the wounds of lovers tender hearts giving them oftentimes secret presages of approaching misfortunes relating to their love; as many other wounded men have the unhappy privilege of being able, by feeling of pain, to discern such approaches of ill weather, as affect not unhurt men.

Didymus therefore being quickly too much ascertained of the unwelcome news of the distress of his fair mistress, was too generous a lover to deliberate, whether he should expose his life for her rescue; his deliberation being only about the means, how to make so difficult an attempt a prosperous one. In order to this he happily finds out one of the officers of the guards, that were placed about the infamous house to which *Theodora* was condemned; who, having been his fellow soldier in the *Roman* armies, he hoped would, either for the sake of virtue or of *Didymus*, be prevailed with to further so handsome a design as his.

WHEREFORE addressing himself to this commander, with a very obliging and yet civil freedom: Generous *Septimius*, says he, I cannot but look upon it as one of the chief advantages I have obtained by venturing my life in the *Roman* camps, that I had the happiness to be acquainted with you there, and to be a spectator of your gallantry; which did not only then raise me to a desire of imitating it, but allows me now to own a request to you, that none but a gallant person ought to be entrusted with, or would easily grant. Generous *Didymus*; replies the *Roman*, when I accompanied you in following our propitious eagles, I found so great a contentment in your acquaintance, and so strong a spur to glory in your examples, that I looked upon the advantage of having been your fellow soldier, as preferable to the honour of leading the most numerous troops I may at any time command; and shall think all the hazards I then exposed myself to, abundantly rewarded, if any power they have procured me may enable me to do you service: tell me then frankly, in what case, and after what manner, you would have it employed for you; and as I assure myself, that so virtuous a friend as *Didymus* will desire nothing but what is just, so he may assure himself not to be refused any service, that is but dangerous.

OUR lover, emboldened by so encouraging a declaration, first made him a very grateful acknowledgement for it, and then proceeded to say: If you have ever had the happiness to be acquainted with *Theodora*, or so much as to have seen her, it would be needless, as well as improper, for me to offer at giving you a character of her, which you must needs think injurious to her: but if you have not, the shortness of the time will only permit me to assure you, that not only she has given me those sentiments of her excellencies, that I never had, nor ever thought myself capable of having, for any of her sex; but that in other persons, strangely indisposed to admit such impressions, she has often excited such wonder and such flames, as very rarely have been produced in other men, and, perhaps, more rarely been merited by other women.

THIS admirable person, for exercising, among other virtues, that of an invincible constancy to her religion, and refusing to sacrifice to *Venus*, *Flora*, and some other of those deities, whom her perfections might, though her religion did not, exempt from adoring, is by your savage president condemned to be exposed to the public lust; and a party of those gallant *Roman* soldiers, that used to be so gloriously led on by you, to win battles, conquer kingdoms, and enlarge at once the fame and limits of the empire, are now employed to captivate innocent virgins, and defend their brutish ravishers. You may easily guess by this, continues he, that my request is like to prove

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an earnest one; that you would please to treat with some of those soldiers of yours, in whom you think you have the greatest interest, and dispose them to assist me in rescuing *Theodora* out of so infamous a prison, and accept from me greater recompences for doing a handsome action, than they can expect from the president, for doing a barbarous one. I hope I need not tell you, in the haste this affair requires, that all possible care will be taken to keep you from being endangered by *Theodora's* deliverance; nor will I add, how inexpressible an obligation you will lay on me, to heighten my gratitude to some proportion to your favours; because I know it must necessarily fall short of them, and are due to a person, that loves to do gallant actions for their own sake, and had rather have great debts of gratitude remain due to him, than paid to him: wherefore I shall only mind you, that the time is so short, that if your assistance be not as quick as obliging, I fear it will be as ineffectual. I shall quicken you only by assuring you, that, when you act for the accomplished *Theodora*, you act for a person, that has a right to all that beauty and virtue can give one a title to.

WITH the same freedom, replies *Septimius*, with which you have owned to me your religion, I declare to you, that mine is that of my country, and my ancestors; and that I worship those propitious deities, that have made the Romans the conquerors of the world, and rewarded those, that adored them, with an universal monarchy. But though I exceedingly approve so triumphant a religion, yet I confess to you, that I do not like the ways, that the president takes to propagate it; such cruel methods being apt to make the world suspect, that our best argument is force; and whilst the persecutors think it a glorious thing to see the temples filled at any rate, I had rather see in them fewer but sincere votaries, than have them thronged with such pusillanimous dissemblers, as would not come in, unless they were scared in thither. And though terrors and torments work sometimes upon the weaker sort of Christians, yet the more resolute do so often despise them, that our persecutions convert not those unhappy persons, but frequently stagger many of our own; and I confess freely to you, *Didymus*, that all the Christians arguments work less with me, than our inhuman manner of confusing them. But I do not only disapprove, but detest, this infamous practice of our president; which makes him lose not the respect only and the pity, but the common humanity we owe to women, and think to do the goddesses a service by disfiguring their fairest images here below with the most shameful of blemishes. I cannot bring myself to imagine, that such gentle deities can like such barbarous worshippers, who not only immolate to them the lives of men, but, what is far more precious, the virtue and honour of women; for if I could believe they like such sacrifices, I should think them unworthy of any sacrifice at all. You will easily therefore, *Didymus*, credit me, that I was absent, when my soldiers were put by the insolent judge upon so mean an employment. He durst not have offered to have obtruded it upon them, had I been there; or if he had, I had dared to use him as his insolence had deserved. But without losing time in passionate expostulations, about things made remediless by being past, let us speedily apply ourselves to the rescue of *Theodora*. For, though I have heard strange things of her, and such as made me think fame a great flatterer, if not a frontless liar, yet I believe the reports about *Theodora*, as I believe the Delphic oracles, now that I find so undeniable a testimony of her merit, as her being your mistress. I will therefore without delay prepare some soldiers to assist you in her rescue, and I cannot doubt the success in an attempt made to serve a distressed beauty, and a generous friend. If there be occasion, you need not doubt of my more openly appearing for you; for how highly soever such an action may provoke the president, or even the Emperor, I hope to let

you see, that you have trusted a Roman, a person, that had rather be the object, than the minister, of their cruelties, and would not be accessory to such a mis-employment of absolute power, to be made a sharer in it.

As soon as *Septimius* had ended these words, he did, to prevent those acknowledgements he saw *Didymus* was about to make him, take that gallant youth by the hand; and leading him towards the place, where he expected to find the soldiers he most confided in, he entertained him in the way about the hopefulest expedients for the compassing of his admirable mistress's rescue. And having afterwards sent for the two persons he thought likeliest to be prevailed on, to a convenient place, near to that, to which they had brought *Theodora*; he briefly, but pathetically, declaring to them, how much the brave *Didymus* was his friend, and how much he deserved to be so, enflamed them with indignation at the savage president's disgracing them, by so infamous an employment, as they were now about; and then assured them of rewards from *Didymus*, suitable to the liberality of so generous a person: after which withdrawing himself, to give *Didymus* a short account how far he had proceeded, he left the rest to be compleated by him; who, prompted by his native liberality, and his high concern, did not stay to cheapen his mistress's liberty, but, with the hasty passion of a lover, proffered them more than even *Septimius's* promises gave them reason to expect; nor would he have declined to embrace any articles of agreement they could have proposed, though the parting with his life had been one, so *Theodora's* deliverance were another.

THE sense these soldiers had of the affront put on them by the president, joined with the ambition they had to please their loved commander, and the gratitude his friend's profuse bounty had lately obliged them to, made them quickly accommodate *Didymus* with a military habit, and prepare some of their comrades to allow him the first admittance into her chamber; partly by sharing some of the newly received presents among them, and probably by representing him to them, when thus prepared, as a person, who, having been passionately in love with *Theodora*, and been scornfully slighted by her, was desirous, at any rate, to satisfy at once his appetite and his revenge. And, by this means, before that short time was expired, that had been, as an act of grace, allowed the disconsolate virgin, to deliberate, whether she would yet comply with the judge, an entrance into her chamber was permitted to her lover; who (in order not only to his present, but further design) had purposely closed the vizor of his helmet; upon which score, not being knowable by his fair mistress, he met from her the reception we have formerly related.

C H A P. II.

THOUGH in the sad condition, wherein our disguised lover found his desolate mistress, her sorrow and her fears did somewhat cloud her beauty, yet they could not hinder her looks from being so charming and majestic, as to create less pity than respect. Wherefore with gestures, wherein this was as visible as he could make it, he told her, without approaching too near, Do not, madam, I beseech you, add to your other troubles, the apprehension, that, because I appear in the circumstances of a ravisher, I come to commit a rape. *Theodora* is so great an ornament to the Christian religion, and her purity is an ornament so dear to *Theodora*, that heaven will not permit, either that *Antioch* should be robbed of one, or she of the other; and therefore that Providence, which you have so generously trusted, has sent me to your rescue, which, after the care I have taken to dispose things without doors, it will not be difficult to compass, if you please to make use of the military habit I have brought hither,

hither, to disguise and convey yourself hence. Nor need you be solicitous what will become of me, for I am under the same care of the same Providence, that now justifies your reliance on it, by providing for your escape: and I, that found means to come in hither, may be successful in attempting a retreat; or, if I should not succeed in it, I shall not miss the joy of paying my duty, where I had the most desire and cause to do it, and shall leave the world with the satisfaction of having highly obliged it, by the preservation of the most accomplished person in it. And, madam, (continues *Didymus*) that you may not doubt the willingness, or the intentions, wherewith this offer is made you, be pleased to know, that it comes from the now fortunate *Didymus*, who justly thinks, that, in aspiring to your acceptance of it, he does less proffer a service, than beg a favour, that will not only be a full recompence, but a high obligation.

THE name of *Didymus*, and discourse so suitable to it, made by him, that assumed it, soon dissipated the dismal apprehensions his habit and her circumstances had given her: she knew so well his courage, his virtue, and his love, that nothing unlawful or mean, was to be feared; but the boldest things, if they were as noble as hazardous, might justly be expected from him; so that this attempt did perhaps as much oblige her, as it surprized her. Wherefore, as soon as she had recomposed her lately disordered thoughts, she told him, with looks serene enough to let him see how much she trusted him; This action, generous *Didymus*, is of a nature so extraordinary, that my ingratitude would be so too, if my sense of it were not. To own and rescue a persecuted and affronted maid, and to do it with more hazard than you need run in the Roman armies, to purchase fame and honours, is an action so disinterested, and so unexampled, that I want words to celebrate it, as well as merit to deserve it, and power to requite it: but I admire so rare an effect of virtue (continues she) can consent to the destruction of its author. No, generous *Didymus*, it is enough, that the virtues of Christians be treated as crimes by the Romans; they must not meet the like usage from *Theodora*: she must not purchase a life, that she values as little herself as others have cause to do, at so high a rate, as your partial charity persuades you to set upon it: for even those, that do now most pity me, would repine at the preservation of my life, if it should cost that of a hero; especially, if I should designedly be necessary to so great a loss; which, accompanied with a public indignation, and my own reproaches for my ingratitude, would certainly make that life a burden to me, that at so dear a rate you would preserve as a blessing. But——

HERE *Theodora* was going to proceed, when her grieved lover, fearing that, if she did so, she might make some declaration unfavourable to his wishes, thought fit to endeavour to prevent it, by saying to her, with a profound respect, Ah, madam, do not make your mistaken compassion more cruel to me, than the severity of the Romans themselves, which we Christians justly tax, can possibly be: for they will but, in a few moments, take away that life, which you would, at once, protract and render miserable. Do not, I beseech you, madam, (continues he) think my services meritorious, because they are paid you in this place, and in your persecuted condition: no, madam, *Theodora* has prerogatives enough to make many less unworthy (though not more zealous) than I, ambitious to serve her, in what circumstances soever Providence shall think fit to place her. Whatever the Romans, that worship fortune and victory as goddesses, and find their prosperity the powerfullest argument to support and spread their religion, may think of sufferings embraced for conscience sake; sure we Christians, that adore a crucified Saviour, who, as He took upon Him the form of a servant, was put to death between two thieves, as a slave and a malefactor too, ought not to let any persecutions, or indignities, lessen our veneration or concern for those that chuse to suffer for Him, and imitate as well as

own Him, whatever it cost them. Nor, madam (pursues *Didymus*) needs your having been brought to this place make you think yourself at all dishonoured, in the opinions of those that can make just estimates of things: they look on sufferers for truth with his undeceivable eyes, that, by one of the pen-men He inspired, having mentioned those persons, that, for religion's sake, were imprisoned, destitute, tormented, affronted, forced in the skins of beasts, to wander like them in deserts, and lodge in dens, honours them with this character and testimony, more glorious than all the panegyrics of orators, and laurels of conquerors, that the world was not worthy of them: and such judges will think *Venus* an infamous courtesan, though the Romans adore her in their temples; and will not think *Theodora* the less excellent person, for having been condemned, on the score of virtue, to a scandalous place. Honour were a mean thing, and not worthy to have its loss much feared, or regretted, if we could forfeit it without having forsaken virtue, and much more, if we could be deprived of it for having closely followed her. Nothing can blemish true reputation, that cannot be declined without manifest injury to religion, which justifies our acting whatever it imposes. The angels themselves, that were sent to *Sodom*, scrupled less to go thither, than to disobey Him, that made it their duty to do so; nor were polluted by entering into that abominable place; and, being attempted by the brutish inhabitants of it, carried thence the angelical purity wherewith they came thither.

DIDYMUS thought fit to say what has been repeated, that he might console so chaste a virgin as *Theodora*, who had still enjoyed, as well as merited, a spotless reputation, by assuring her, that the barbarous affront she had been exposed to, for constancy to her religion, had not, among unbiassed judges, lessened the high esteem her former life had justly given them of her virtue: but he would not discourse long of a subject so nice, that it was difficult not only to insist on it, but so much as to mention it, without being uneasy to so tender a modesty as hers he was speaking to. Upon which account, passing on to another argument, he told her, These things I have mentioned, madam, to let you see, how little I can pretend to merit by the circumstances of the duty I pay you; and consequently, how little you need scruple to accept of my further service, without which my past endeavours will be useless to us both: and give me leave to own to you, madam, that it was not without much trouble, as well as surprize, that I heard the incomparable *Theodora's* merit so much injured, as to have the valuableness of my life put into the balance with that of her's, nay, and made to preponderate. Alas, madam, there are legions, that, as well as I, dare expose their lives to the greatest hazards, and run greater dangers for some despicable pay, or a few worthless leaves, than I do to serve my religion, and the fairest professor of it. Every day affords thousands of such men as I; else the Roman camps would not be so frequently recruited, and those numbers, that fall in breaches, or in battles, would not have their rooms so ambitiously supplied by men, that see them do so. But such persons as attain to be both the ornaments of their religion and the honour of their sex, must be so excellent, and are so rare, that it is not every age that produces so much as one of them. Such exemplary ladies, do as well improve as ennoble the times and places they live in; the respect and love men have for them, makes their good counsels very persuasive; the loveliness of their persons is so diffused to their actions, as, by making men forward to take them for examples, adds to their virtues both a great splendor and a powerful influence. That *Theodora* is not only one of that small number, but eminent in it, nothing but her presence, could keep it from being uneasy for me to evince: but, madam, (continues he) though in such circumstances, as mine, your scrupulous modesty may keep men

silent, yet it ought not to keep them from being just. Your profound humility may draw a curtain, that may hide your virtues from your eyes; but, in the eyes of others, it cannot but increase their number, and exceedingly add to their lustre. You need not therefore, madam (pursues he) scruple to receive the service I aspire to do you, upon an injurious apprehension, that it is above reward, whilst indeed it pretends not to any at all, except the satisfaction and honour, that will be inseparable from the performance itself. Here *Didymus* paused for some moments, being sensible, how difficult a task he was entering upon; since it was, without prejudicing his love, to own to his mistress herself, that he did not serve her upon the score of that: but however, the sincerity of his affection, and the great desire he had to make his persuasions prevalent, hastened him to prevent her answer, by thus prosecuting his discourse: It is true, madam, that *Theodora's* perfections did not miss in me, to have the operation, that they are wont to have upon those, that enjoy the opportunities of considering them: and if she had been in a distress greater than that she is now in, though her religion had not at all contributed to bring her into it, I should joyfully have exposed myself to a greater hazard, than I now run, to rescue her from it. But, madam, that is not our case; for that, which now brings me hither, is none of those sentiments, that, if I were possessor of a crown, would bring me to lay that and myself at your feet, and think myself more happy in your acceptance of it, than in all the advantages and prerogatives that could belong to it: for, madam, the resolution, that led me hither, was not inspired by the fair, but by the devout and virtuous *Theodora*. If she had no charms, but those, that cannot be seen with bodily eyes, or if her visible beauty were but moderate, or none at all; her exemplary piety and unshaken constancy, shining in such extraordinary expressions of them, as she has this day given, would make me think myself unworthy of life, if I should stick at hazard-ing it to save so precious a one as her's, and what I knew she would far more unwillingly lose; and thereby do some right to divine Providence, which, by so unexampled a reliance on it, was thought, in some sort, engaged to answer so uncommon and intire a trust. After what she did for Christ, I did not think I could do enough for her, if I did less than I have endeavoured to do; and therefore, madam, (concludes he) I hope as well as beg, that you will no longer scruple to accept of that rescue, that Providence offers you, by an unmercenary and most willing hand, but will vouchsafe to make use of this military garment, (at which words, *Didymus*, with great respect, pointed at his) and allow my endeavours, by procuring your safety, to secure my happiness.

To this moving speech, the fair person, that it was addressed to, returned this calm answer:

THOUGH the handsome and obliging things you have been pleased to say, generous *Didymus*, have made all the impressions on me that they ought to have; yet I must, with your pardon, freely tell you, that they naturally afford an inference, quite opposite to what you would conclude from them; since, by discovering more and more of your gallantry and friendship, they let me still further see, how much the world would lose, by being deprived of so much virtue, and how unexcusable I, above all others, should be, if I should be willingly accessory to that loss. Your too too excessive compliments I must not pretend to answer, since it would be too great a reflection on your judgment, as well as mine, to think you meant them for any thing more than what I have called them. But in answer to the serious part of your discourse, I shall tell you, that, if I had proceeded in what I was going to say to you, when you interrupted me, I had, perhaps, prevented some of the things you have said, by freely acquainting you (as I now mean to do) with the state of my case, and the

intentions it suggested to me. When the inhuman president (continues *Theodora*) had condemned me, either to offer sacrifice in an idol temple, or be led away to this infamous place, I was in such a perplexity and agony, as can hardly be conceived, especially by a person that is not of my sex; for death itself was thought too mild an evil, to be one of those, among which I was condemned to make my choice. On the one side, the infamy of this detestable place was that, which I could not think on, without the utmost horror and indignation; and not only my sex and breeding, but even the dictates of more than one virtue (modesty and chastity) concurred to heighten my abhorrence of it: but, on the other side, I remembered, that I did not vow obedience to God with any exceptions or reserves; that I was both a disciple and a worshipper of a persecuted and affronted Redeemer, for whom (though there were not an infinite inequality between our conditions) I could not suffer more, than He had already suffered for my sake; having not only *endured the cross*, but *despised the shame*, which the Jews insolent malice, and the Romans barbarous custom, had annexed to it. And I thought, that, perhaps, Providence had led me into this distress, to give me an opportunity of shewing, that I could do more than die for Christ. But I must not now trouble you with the various thoughts that distracted my mind on this dismal occasion, on which, all that I could say to those, that rudely pressed me to give a positive answer was, that of the things they proposed, I plainly saw, that both were to be refused, and therefore I could make choice of neither. But, since I would make no election for myself, their malice soon made one for me, of this detestable place. I was so confounded, and, as it were, stunned, at the first steps they forced me to take towards it, that I scarce knew what to think, or what I did, save that I remembered, that idolatry was in the sacred books represented as a most odious, though spiritual fornication; and that apostacy would be my own crime, whereas the consequences of refusing it could make me but the object of another's: and remembering myself to be a daughter of him, that against hope believed in hope, to follow God's call, I did, like him, obey, not knowing whither I went; yet having this satisfaction, that I acted according to the dictates of a well-informed conscience; so that, whatever the way might prove, I need not fear to be misled by closely following an infallible guide.

HERE the chaste virgin's words were a little interrupted by the flowing tears, and the inevitable discomposure, that were produced by the sad remembrance of the distressed condition she was recounting; but having, as soon as she was able, suppressed those visible effects of her virtuous grief, she thus pursued her discourse:

REVOLVING these and the like thoughts in my mind, I arrived at this infamous place; and being for a while left alone in this room, to try whether yet I could be brought to change my mind; the nearer approach of what I was to endure, making it look more hideous to me, than, till then, I thought it was possible for any thing to appear, made me presently think of flying for refuge to the dark sanctuary of death, and, by dispatching myself, drown in my yet untainted blood both my own dismal fears, and my persecutor's brutish hopes. But then there came into my mind what I had been often taught, and, whilst I was unconcerned, judged rational, to believe of the unlawfulness of killing one's self upon any account whatsoever. I considered, that God, who made our love unto ourselves the standard of the affection we owe our neighbour, in forbidding us to destroy another's life, must be supposed much more to prohibit us that violence against our own. And if fratricide be justly listed amongst the blackest crimes, because of that relation the slaughtered persons have to those that kill them; how criminal upon that score must be the murder of ourselves, where the relation is not nearer, only because it is too near to be properly any at all! The sovereign

Author and absolute Lord of our lives having thought fit to employ us here in his service, we cannot, without violating our duty to Him, desert it, until we have performed his errand, which is, to glorify Him by our lives, till loyalty to his truth, or his commands, convince us, that we may better glorify Him by our deaths. Such considerations as these would, I hope, have restrained me from ending my life with a crime; but the thoughts of it were quickly suppressed, by my remembering, that in this place I was destitute of instruments to act it with. Wherefore remembering, that *Daniel* had been preserved, though not from the lion's den, yet in it; and his three friends were not delivered from the fiery furnace, till they had been cast into it; and having learned by those examples, that no succours can come too late, that God designs for our rescue, I betook myself to prayer, as the most hopeful, as well as the most innocent course, I could take; and with an ardency, heightened with the extremity of my distress, I was beseeching God, though with the loss of my life, to preserve a purity, that by his grace had been hitherto kept unblemished, when your unexpected entrance brought me a return of those prayers I had yet scarce uttered. Judge then, generous *Didymus*, (subjoins *Theodora*) by the condition I was in, how much I must think myself obliged by so brave and seasonable an attempt to deliver me out of it.

To serve so bright a virtue, lodged in so noble a shrine, I thought, madam, (says *Didymus*, interrupting her) to be as much my duty, as to have found an opportunity to do it is my happiness: and if you please to permit me, as I now hope you will, the honour and satisfaction of compleating my endeavours to deliver you, I shall much more value myself upon the having paid you that service (though it be more proportionate to my power, than to my desires) than if I had rescued a Roman general, or, for successful attempts, been made one myself.

WHEN thanks are purchased by merit, replies *Theodora*, to disclaim a right to them, does not forfeit it, but increase it; nor need you make me any new professions, since, after the testimonies you have given me already of your virtues, and your friendship, I should make myself unworthy of them, if I doubted of their reality or greatness. Yes, *Didymus*, I believe what you declared of the disinterestedness of your proceedings, in the rescue of a person of no greater merit than I can pretend to; since the circumstances of your attempt make it appear too generous to let me suspect, that the aim of it was other than noble too: and indeed, after what you have done (continues she) it would ill become me to scruple to be further obliged by you; and therefore I shall venture to make you a request, as soon as I shall have acquainted you with the reasons it is grounded on.

Didymus, being surprized at this welcome declaration, was going with transports to assure her he could deny her nothing, nor obey her in any thing without joy, when she prevented him, by thus continuing her discourse: You know, my generous deliverer, that virgins have so great and clear a right to keep themselves such against all outward assaults, that monarchs themselves (whose force is not to be by force opposed, when it tends but to deprive us of our lives) may be forcibly resisted, when they strive to offer violence to our chastity. Since, then, an untainted purity is a jewel, that the possessors are allowed to preserve and defend, even by uncommon ways, if others will not serve, and such as would in other cases be unwarrantable; though I do not, as I lately told you, think it lawful, as many do, to secure virginity by self-murder, yet I cannot disapprove their opinion, that allow a virgin, in case of extremity, to implore that death from another's hand, that she is forbidden to give herself with her own; since, in such a calamitous condition, heaven, by debarring her all other ways of escaping from defilement, seems to approve of this. And the scripture in-

forms us, that though the prophet *Jonas* held it unlawful to drown himself, yet he *Jonah i.* persuaded those, that failed with him, to cast him bound into the sea, when neither ^{12.} they nor he expected he could out-live many minutes (as indeed it was not without a miracle that he did). Wherefore, pursues *Theodora*, if you will perfect what you have so obligingly begun, you must lend me your arm and sword, to free me by a speedy death from mischiefs much greater than it. The Romans will easily believe, that my resistance and provocations transported you to a revenge, at which the barbarous usage I have received at their hands makes it unlikely they will be much offended: the grant of my request will not hinder you from being, what you are pleased to think a title, *Theodora's* deliverer; for in the estimation of equitable judges, as well as in hers, it will suffice to give you a right to that title, that you have delivered her from her greatest calamity and danger: nor will the good office I desire be inconsistent with my obtaining the honour of martyrdom. St. *John* the Baptist, because his bold zeal for the laws of religion gave the first rise to those persecutions, that terminated in his death, is justly reckoned among martyrs, though he was privately beheaded in his prison at the solicitation of a Courtesan: and if one willingly suffers death for the truth, or the interest of religion, there needs not a scaffold or a stake, and a public executioner, to make such a person a martyr. And since the persecutions, that now make havock of the church, are like to continue long; and since I am resolved, by God's assistance, never to avoid them, by any either unlawful or unhandsome way; the escape you would persuade me to, would but for a while delay those sufferings I ought not to shun, and would make them much less acceptable, by my having endeavoured to avoid them; especially by an action so mean, if not criminal too, as to consent to the loss of an excellent person, that most generously exposed himself for my safety. Deny me not therefore, concludes *Theodora*, with tears in her eyes, the last request I shall ever make you; but by sheathing your sword here, (at which words she pointed, with blushes, at her fair and innocent breast) be pleased, by one quick and charitable stroke, to perfect my deliverance, without making me stain it with the blood of my deliverer: free us both from eminent danger, me of being dishonoured, and you of being tormented; and by the same act of friendship secure me the coronet of virginity, and procure me the crown of martyrdom.

GREAT was the surprize, and greater was the trouble, wherewith *Didymus* heard the conclusion of this discourse: in answer to which, as soon as his astonishment would permit him to speak; Ah madam, says he, what have you ever seen in the unfortunate *Didymus*, that could tempt you to make him so strange a proposition? that I, whose errand hither was to venture my life in your service, should myself destroy the admirable person I came to rescue; and that *Didymus* should imbrue his guilty hands in *Theodora's* innocent blood, to save one drop of which he would gladly shed all his own? As your piety deserves to be the pattern of more than one age, so I doubt not, but that in times very remote from ours, your memory will shine as bright, as your virtue and your eyes do now; and then, how hideous a monster must I appear to posterity, that will look upon me as one, that could in a trice pass from pretending to be your deliverer, to be really your murderer; and this for no other reason, than that you were pleased to manifest a great concern for my preservation? And pardon me, madam, (continues *Didymus*) if I tell you, that your generosity makes you forget some of your other virtues, and even of the dictates of the religion you have hitherto adorned; since your commands, if obeyed, would engage me to commit a crime, and make you yourself more than necessary to it. For, madam, since you acknowledge self-murder to be unlawful, how can your commands
give

give me a right to take from you a life, that you have not power to dispose of? And what excuse can I have, without so much as the pretence of acting under authority, to destroy an innocent person? For, madam, since I am to declare, why I presume to do the thing in the world I would least be put upon, to disobey *Theodora*; give me leave to tell you, that, should I execute what you require, the action would not be excusable in either of us. For as *Adam* sinned in doing a forbidden thing, though she, that prevailed with him to do it, *was first in the transgression*, and the Jewish prophet was torn in pieces by a lion, though he did what he was seduced to by the persuasions of a prophet; so the scripture clearly condemns *David* of murder, because he killed *Uriah*, though not with his own hand, yet with the sword of the children of *Ammon*: and the scripture tells us too, that God plagued the children of *Israel* in the wilderness, because, as the text expresses it, *They made the calf, that Aaron made*. And indeed, by whatever hand innocent blood is shed, the guilt of it will light upon the person that procured it to be spilt. And to this I must add, that since Christians are, in some cases, not only permitted, but exhorted, if not commanded, *to lay down their lives for one another*; the high value and concern I justly have for yours, makes me conclude, that this is certainly one of those cases, and consequently, that I may lawfully offer you a service, which you perhaps cannot lawfully refuse: since Providence has left you no other innocent way, than the acceptance of it, to escape your present danger. And the guilt of self-murder may, for aught I know, be contracted, not only by a positive act, but by an inflexible refusal of the proffered means of safety. Pardon me, I beseech you, madam, pursues *Didymus*, if the great concern, I have for such a person as *Theodora*, has extorted from me a greater plainness of speech, than my profound respect for her would permit me, upon any other occasion. And because I perceive, that that, which makes you most scruple to grant my humble request, is, that your superlative generosity, and what your humility persuades you to think gratitude, make you solicitous for the preservation of a life hazarded for your sake; I must assure you, madam, that your inflexibleness will no way make provision for my safety: for if I should be condemned by your cruel commands to leave you exposed to the barbarous and defiling rudeness of those brutish satyrs, that impatiently wait without, the regret and shame of having missed the honour of *Theodora's* rescue will give me far greater torments, than the Romans can, for having effected it. And I must add on this occasion, madam, (continues he, not without some change of colour and voice) that some sentiments (which, though I think not this a fit time or place to name, have been much confirmed and heightened by what I have this day had opportunity to observe) have so fast tied my happiness to your welfare, that the presence of my soul is scarce more necessary to my life, than your safety is. Nor fancy, madam, that the belief I own of the unlawfulness of self-murder, will secure my life; for there are other ways to procure death to him, that is weary of life, than his own sword, or a draught of poison; since passion alone, when raised to a competent degree, may do the office of either of those. And since joy itself, though the most pleasing and friendly of the passions, has by its excess proved destructive of men's lives; why may not grief, and shame, and indignation, which are passions more violent, and very unfriendly to nature, be able to produce as fatal effects? And to shew you, madam, (continues *Didymus*) how much reason I have to think, that your condition dispenses me from obeying the dictates of your generosity, let me, — But before *Didymus* had annexed his reasons, a noise made without gave him a hot alarm, and made him fear the patience of some, that waited without, would not last very much longer; and therefore addressing himself to *Theodora*, with a countenance as petitioning as his words,

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and eyes, in which his courage could scarce repress the tears; how long, madam, says he, will you upon groundless scruples neglect an opportunity, whose omission will be irreparable? And how can you justify to God, the slighting the means his providence presents you of easily securing your safety? Ah, madam, (then concludes *Didymus*) by one quick and necessary resolve, regain your liberty, preserve your honour, and secure your life. But if nothing, that has relation to yourself alone, will move you, be pleased to reward the services I have essayed to do you, with the implored grant of your own safety; and permit me, for this once, rather to serve you than to obey you. Nor need your generous sollicitude for me hinder or retard your resolution: the world will not blame a spotless virgin, for doing what is necessary to keep herself such; nor look upon it as a part of ingratitude, to grant to one, that has done his best to serve her, a recompence, that he is so ambitious of, as to venture his life to obtain it at her hands. In short, madam, (for the time allows me not a long discourse) if your cruelty will not permit me to prevent your death, grief, and other passions, will not allow me to survive it; and then, (supposing I should fail of making a retreat) would it not be a much more happy fate, that the constant *Didymus* should die for having saved the matchless *Theodora*, than for having lost her?

C H A P. III.

TO these pathetic words he thought not fit to stay for an answer; but, retiring to a corner of the room, he divested himself of his military coat, and upon his knee presented it to *Theodora*. She, in the mean time, reflecting upon his arguments, was by their force convinced, that the motion she had made him of killing her, was grounded upon a dangerous error. And the noise, that had been made, in the outward room, alarming her, at least as much as it had done him, let her see she had no further time left her to deliberate. And therefore, being prevailed with, by supplications made in so persuasive a way, that it appeared a far less cruelty, even towards him, to accept, than finally to refuse, his offer; she first made her blushes and her silence intimate her consent, and then declared it more expressly, by raising him, and taking out of his hand what he presented to her. And to his joy (which his foresight that his success would be fatal to him could not hinder from being very great) she received from him instruction how to put it on, and permitted him (tho' not without strange disorder in her mind and looks) to assist her; for as it was absolutely necessary to do it, so he did it with all imaginable care, to distress so nice a modesty as little as was possible; and therefore, as soon as ever he had done that, with all the respect and decency the place and occasion would by any means permit, all that could be done without him, he left her to do herself, withdrawing to a part of the room whence he could not see her: which retreat he was induced to make, not only out of civility and respect, but perchance because the dangers, that threaten internal chastity, have this peculiar fate, that usually those persons are most careful to shun them, that are the most resolved and the best able to surmount them.

As soon as the mutual exchange of their habits had made it decent for them to discourse together, the disguised virgin, with cheeks covered with blushes, and with looks so obliging, that they alone would have recompenced *Didymus* for any less service than that she now received, addressing herself to her benefactor; If your reasons, says she, had not convinced me, that I could not without a crime free myself from my wretched condition by death, and if yet death were not the only way, by which, if I decline your generous proffer, I can possibly shun, what I far more apprehend than death, dishonour; I should not leave you in a danger, wherein only your con-

cern for religion and for me has engaged you. But I doubt not the same charity, that put you upon making me your generous proffer, and pressing me not to decline it, will make you pardon a fault, to which your own reasons and importunity have made you highly accessary; especially since I know you think a tenderness of honour, and an abhorrence of all defilement, to be things so allowable in a virgin, as very much extenuate, if not justify, what they require of her. And indeed I shall do you but right, when I thankfully acknowledge, that, in this whole transaction about my rescue, your carriage has been such, as would leave me no doubt, if ever I had been so unjust as to have any, of the purity and disinterestedness of your intentions, by which I am not a little confirmed in the opinion I have always had, that virtue may inspire as noble and as hazardous enterprizes, as passion can. I know, that in this day's work you aimed at higher retributions, than could be expected from one in my condition; but yet I think myself obliged to assure you, that your heroic acts of virtue and friendship have not been exercised towards a person insensible of them; but that your merit and your favours have produced all the esteem and other sentiments, which they ought to produce in a person, that is not altogether incapable to discern and value them. And if the prayers of a disconsolate virgin, then saved by you, when all the rest of the world had abandoned her, can have any interest at the throne of grace, they will obtain for you blessings as great as your generosity to me has been, and not less lasting than my sense of it will be; and you will, during a long protracted life, either be allowed quietly to enjoy the glory, your many meritorious hazards of it have purchased, or else be enabled to find a happiness in your very sufferings, by virtue of those peculiar consolations, that are reserved for a persecuted condition; as anciently manna was vouchsafed the *Israelites*, only whilst they were exiles in the wilderness. The quick success God has been pleased to grant my prayers for my own deliverance, lets me not despair to find Him propitious to those I shall with no less ardency put up for yours: but, if your charity should expose you to further danger, I solemnly promise you, that you shall find I have been instructed, as well as obliged, by your generosity, and would not have left you exposed for my sake, that I might shun any danger, that had threatened but my life.

AND now the mournful virgin, being to bid her accomplished votary a farewell, which probably enough would prove the last, by a manifest change in her countenance, and the tone of her voice, and by the multitude of tears, that fell from her fair eyes, convinced him no less of the trouble she was in upon his account, than any verbal expressions could do it; though she said to him, in a most obliging manner, Farewel, my generous deliverer; and may that God, who sees with what reluctance I consent to your danger, free you happily from it, and richly recompense that noble charity, that led you into it. I hope we shall yet see one another again upon earth: I am confident we shall meet joyfully in heaven, by which I must confess myself very highly favoured, not only in my deliverance, but in the instrument of it; since God makes me not beholden for my rescue to any common person, but is pleased so to order it, that I receive the greatest of earthly benefits from the most generous of men.

MADAM, replies the much troubled *Didymus*, your own unequalled perfections, and the operation they have had on me, make me so much yours, that your wishing me happy does more towards the making me so, than your humility will allow you to be aware of. You have too much merit, madam, to let the services I have paid you, have a title to any; and what I have had the happiness to perform, is but what was every brave man in *Antioch's* duty to endeavour: but if your goodness will needs make you think, that my poor services should have another (for they can scarce have

have a greater) recompence, than you have already given them, by suffering them to contribute to your safety; and if you will vouchsafe to allow the memory of him, that did them, a room in your thoughts, (which is the happiest station it can aspire to upon earth,) I humbly beg your faithful servant's image may be looked on without any troublesome degree of pity; since his condition will then need none, and the idea would very much misrepresent the original, if it should disquiet her, whom he never approached but to serve her. It is suitable, madam, to this frame of mind, that for *Theodora's* sake I must now deny myself so much, as to hasten her departure, lest some cross accident should prevent it: at which words, looking on her with a countenance, that all his courage could not keep from a discernible change, Farewel, said he, incomparable *Theodora*; may you continue long the ornament and the pattern of your sex; and since we see, that some fruits may be as well preserved in honey, as others in brine and vinegar, may the height of your virtue be kept up, but the objects of it so changed, that by a settled prosperity you may henceforth have occasion to exercise your moderation and your gratitude, instead of your courage and your patience. Once more farewell, concludes he, unequalled *Theodora*; and may you live but with as much contentment, as, if I suffer for you, I shall die with satisfaction.

THOUGH these moving expressions, and the accent, wherewith they were delivered, did very sensibly touch a person so well natured and grateful as *Theodora*; yet she thought the fittest return she could then make to her lover's discourse, was presently to follow the advice he was so earnest to have her speedily embrace: and therefore, bidding him farewell only by a look, wherein high degrees of sorrow and gratitude were plainly mingled, she immediately disposed herself to quit that dismal place; which then afforded a noble instance, how little a great mind can be hindered from dis-closing itself to be so, by the stage it is obliged to act upon: for whilst in divers of the stately temples of *Antioch*, whores (such as *Venus* and *Flora*), and ravishers and adulterers (such as *Jupiter* and *Mars*), were solemnly adored in an infamous scene, dedicated to public lust and violence, the strictest chastity was exercised, and martyrdom itself was contended for.

HAVING once ventured into the outward room, that Providence, to which she had, in such discouraging circumstances, trusted her virgin purity, would not leave the rescue of it incomplete; but, whilst the waiting ruffians were eagerly contending who should succeed the person they took, by the habit, to be *Didymus*, (and whose face they did not wonder to see muffled presently after so savage an action as they supposed him to have committed) brought her safely out of that infamous place: whence, by the least frequented passages she knew, she was quickly conveyed to the house of her dear friend *Irene*, which happened to be nearer than her own.

THERE, to avoid suspicion, some of her friends and relations were met together, to lament her captivity, and join in prayer to Him, that alone could deliver her, to be directed by God how they might (if it were possible) contribute to her rescue. But, though their prayers were probably made with more zeal than hope, they were not a little alarmed, when, looking out to see who knocked at the door, they saw, as they thought, a soldier, who would not have been quickly let in, if *Irene* had not presumed it to be *Didymus*, who was coming to offer his service to his captivated mistress. But it is not easy to express the wonder and the joy, with which they soon discovered that this was not *Theodora's* lover, but herself, whose beauty, and her military dress, would have made her, had the Roman guards discovered her, pass for their *Pallas*: nor was such a habit, though improper for a virgin, unsuitable to a great, as well as chaste conqueror.

BUT though her presence never needed the endearment of a surprise, yet the unexpectedness of it at that time and place, added to the transports it produced, especially in *Irene*, who, after a thousand gratulations and caresses, at length begged, in the name of the impatient company, to know, how the blessing, they all received in her freedom, was procured. To which reasonable request she answered, by making a short but faithful narrative of what had occurred, since the time she was cited before the president, till she came to take sanctuary among them; piously concluding, that, as what she had done not misbecoming a Christian was altogether by the assistance of divine grace, so the succour she received to bring her out of danger, was by the conduct of Divine Providence, which in her delivery made use of the high virtue and generosity of *Didymus*. This relation made the company first return thanks and praises to the divine Goodness, which were followed by the celebrations of the happy instrument of it; every one, as it were, by turns, endeavouring to vye, who should most commend so venturous and disinterested a lover: nor perhaps did *Theodora* herself inwardly dissent from that grateful company; for though her modesty and reservedness kept her from declaring her sentiments, as others did theirs, yet, perhaps, that was because she thought, that, having given a candid account of his deportment, her narrative had made praises needless, the history itself being indeed a panegyric.

AFTER the company's curiosity was somewhat satisfied by what *Theodora* had told them, and both *Irene* and she had made a request to a gentleman, that knew *Didymus* well, to endeavour to bring them speedy notice of what had happened to him, or was like to befall him; the two excellent ladies retired to the apartment of *Irene*. There the pious *Theodora*, having devoutly paid her solemn thanks and praise, for her almost miraculous deliverance, to the divine Author of it, she was accommodated by her friend with clothes besitting her sex: nor was it difficult for *Irene* (though on so sudden an occasion) to furnish her with a habit she liked; for, besides that a person so shaped and fashioned as *Theodora* could make almost any dress graceful, she used to pity the mean vanity of those ladies, that could be either ambitious or proud of what they must owe to a taylor or a dresser, and affected to be taken notice of, not so much for what they are, as for what they wear; and therefore, though she did not scrupulously decline fashionable clothes, because they were so, yet all the ornaments, that passed the limits of the modestest decency, she always as little valued, as she needed them.

C H A P. IV.

BEFORE this rare couple returned to the rest of the company, *Irene's* kindness for *Didymus* made her think she ought not to lose this opportunity of doing good offices to her absent friend; and therefore having (as she easily might) brought the discourse to fall upon his late performances; I hope, madam, says she to *Theodora*, you are now satisfied, that the character I gave you of the greatness of my cousin's virtue, and the ardency of his flame, was dictated more by his merit than my friendship. I were very ungrateful, replies *Theodora*, if I did not willingly acknowledge his generosity to be altogether extraordinary, and that, as he could not oblige me more highly than he has done, so it was not possible, that he should do it more handsomely.

I KNOW, madam, saith *Irene*, that *Theodora* may freely chuse, among all the illustrious youth of *Antioch*, what person she would please to make happy: and, without considering her less obvious, though more admirable perfections, far less beauty than she is mistress of has, in our times, given the possessors a share in the imperial throne, and perhaps too placed them upon the Roman altars. But yet, continues she, since
I have

I have the honour to know you too well, not to be confident, that you value piety and virtue, and a flame regulated and excited by them, above those outward advantages, which weaker spirits are influenced by; I think I may presume to say, that I know not any person in *Antioch*, to whom the fair *Theodora* may, with less condescension, vouchsafe a share in her favour, than to him, that had the happiness to give her so clear a proof of the ardency, the purity, and the disinterestedness of his flame.

If I had not, replies *Theodora*, with a somewhat dissatisfied look, been much surprised at the beginning of your discourse, I had immediately stopped you there, and lamented my infelicity, that *Irene*, whom I thought myself happy in having for my friend, allows herself what is so repugnant to true friendship as flattery is. I could, continues *Theodora*, (without pausing, for fear of being prevented,) easily, and with the approbation of many of the best judges in *Antioch*, return the fair *Irene* her own compliments, if I thought fit to imitate what I cannot approve: and to speak seriously, continues she, neither you nor I, nor any of our sex, ought to think skin-deep beauty as great a blessing, as it is an applauded one; for, without our fault, and in spite of our care to preserve it, a thousand accidents may, and time certainly will, ruin the loveliest faces, and perhaps to that degree, as not in the remains to leave it credible, that ever they were handsome. It is true, that those vain men, whose passion masters their reason, are wont (for the most part with designs we ought not to be proud of) to speak extravagant things, and too often even prophane ones, of the beauties they profess to adore: but though they really meant (which they very seldom do) all they say, in praise of those they represent as goddesses, yet I think a considering person will scarce be very proud of receiving that title from those, who can think, that a few colours and features luckily mingled are sufficient to make a deity. An uncommon degree of beauty, adds she, exposes the owner to extraordinary troubles, from the envy of those that want it, and the importunities of those that court it. And, without as much caution and watchfulness as turn it into a trouble, it too often proves a strong temptation to those that admire it, and a dangerous snare to those that possess it. And if I had the vanity to think, what you would persuade me to believe, I should yet take beauty in a woman to be like a rich perfume, which, though it be a thing very grateful in most companies, and perhaps (especially at first) very delightful to the wearer, yet does often discompose, not only strangers she chances to converse with, but the best friend she has; and not seldom does mischief even to herself, by disordering her head, or casting her into fits of the mother. I beg your pardon, dear madam, says the fair *Irene*, with somewhat of sadness in her looks, that, whilst I had so much beauty in my eye and thoughts, I forgot, that it was in *Theodora*, accompanied with a far greater and scrupulous humility; and I did not apprehend, that I could be thought guilty of flattery, so near to a witness (at which words she pointed to a looking-glass, that hung up in the room) ready to justify more than I had occasion to say. I willingly acknowledge with you, that the amiableness discoverable by the eyes of every gazer is a thing far less desirable than desired, and procures the possessors more praise, than it brings them happiness: and for my part, adds she, if I had the weakness to believe myself mistress of what the folly of some has made them flatter me with, yet I should not be over-much pleased with a quality, that would add to those harms, my frailty makes me guilty of, those which I never intended; and makes ladies so mischievous to those that love them, that, even when they do not rob men of their innocence, they deprive them of their quiet. I confess, therefore, madam, (continues *Irene*) that it was injurious to insist upon the praises of a face, when, how little soever it can be matched in its own kind, it is accompa-

nied with several beauties of a much nobler kind: but that, which induced me to speak as I did, was to let the fair *Theodora* see, that I was justly sensible, how great a thing I begged for my friend, when I implored for him an interest in her favour. And I do the less despair of the effects of your goodness, both to him and me, because I beg them for an absent friend, who is not in a condition to speak for himself; and who, as I perceived by the obliging relation you were pleased to make of his carriage towards you, declined making you any request, when his services were so happy as not to be useless to you. His silence, answers *Theodora*; in such circumstances, had more effect on me, than his passionatest solicitations would have produced: but the thing, I presume, you aim at for him, is of that moment to me, that I cannot think fit to discourse of it, till we can do so with more calmness and leisure, than we can at this time expect. You know, *Irene*, that I have still looked upon marriage, as one of the most important actions of life: and though I think they have too mean a notion of happiness and misery, who imagine, that one creature can make either of them the portion of another; yet I think, that not only the dictates of discretion, but those of sincerity and chastity, oblige a woman to have a great care not to enter into so near and indissoluble a relation, upon any grounds, that are not like to last as long as it, (and consequently, as our lives): and therefore, a woman, that resolves to be what she should be, when a wife, ought to deliberate much upon a choice she can probably make but once; and not needlessly venture to embark herself on a sea so infamous for frequent shipwrecks, only because she is offered a fine ship to make the long voyage with. But, continues the bashful virgin, (not without some little disorder in her looks) since my dear *Irene* will needs make use of the privilege she has to know more of my thoughts, than I would disclose to any other person in the world; our friendship prevails with me to tell her, that, if I were altogether at my own disposal, and could be induced to admit such a change of condition, as I have always been averse from, I should be more influenced in my choice by the shining virtues and extraordinary services of *Didymus*, than by all the advantages, that either titles, or riches, or dignities, could give any of his rivals. But, my dear *Irene*, (adds she) we live in such times, and I, for my own particular, am beset with such circumstances, that it were not only very unreasonable, but wildly extravagant, for me to increase my commerce with the world.

Heb. xi.
38.

For, *Irene*, continues she, in my opinion, a Christian does not deserve to be happy, and a true one cannot think he is happy, whilst the church of Christ is miserable, at least as far as outward calamities can make it. When I see the empire over-run with idolaters and persecutors; when I see ravishers and whores adored in stately temples, and the only worshippers of the true God driven into corners, and pursued even thither; when I see such as God is pleased to declare *the world not to be worthy of*, treated by men, as persons not worthy to live in the world, but daily expelled out of it, with ignominy and torments: when, I say, (adds *Theodora*, with tears in her eyes), I consider the general desolation of the church, and that I am like and willing to be, not a meer spectator, but a suffering actor, in this tragedy; I cannot, in the midst of her sighs and groans, listen to the unseasonable compliments of a lover, or think of relishing any contentment, that descends not from a place too high for persecution to reach. In these sentiments, subjoins she, I am warranted by no less authority than that of an apostle, who, though not unfavourable to the marriage state, disadvises those women, that are free, from entering into it, at least during the present distress, though that were in his time very much inferior to those streights we are now reduced to. Yet, madam, says *Irene*, those expressions of friendship, that a conjugal relation invites, are not only made allowable by it, but commendable;

commendable; and are as real duties of piety and virtue, as divers of the more abstracted exercises of religion. I do not contradict that, replies *Theodora*, but look upon that very thing, as a dissuasive from the state of life you would recommend; for if I could think fit to enter into it, it should be with a resolution to do all, that becomes me in it: and in such a calamitous time as we live in, I could not do that, without coming far more, than I now am, within the world's reach; since I should think it my duty, and perhaps be engaged upon another account, to have such apprehensions for a near friend's danger, as my own would be incapable of giving me. And the contentment I now enjoy in a disposition to quit the world without regret, would be destroyed, or at least allayed, by an uneasiness to part with, what duty and inclination would, perhaps, too much fasten me to. Here *Irene* was going to interrupt her by an answer, when her fair friend prevented her, by thus continuing her discourse; And to me it seems very considerable, that the apostle I lately mentioned, clearly enough intimates, that to persevere in a virgin state, in times of persecution, gives those, that prefer it, the great advantage of serving God more undistractedly; and consequently of being more entirely and uninterruptedly employed in the direct contemplation and services of an object so sublime, that our mind cannot divert to another without stooping to an inferior one. And though it be true, that the duties of a relation may rightfully challenge a part of an engaged person's time and care; yet I see not, why one, that has no need, should enter into a relation, that would make those distracting duties necessary.

THOUGH *Irene* found it scarce possible to answer *Theodora's* reasons, yet her kindness to her absent friend made her unwilling to lose the opportunity their privacy gave her, to make one attempt more in his favour; which she did, by saying to his excellent mistress; But shall not the as faithful as unhappy *Didymus*, be allowed to hope, that if once those dismal clouds, that pour down showers of blood, shall be happily blown over, he may have a particular share in the publick joy and tranquillity? that his sufferings shall end with the persecutions of the church? that those fatal resolutions, that are so destructive to his happiness, may cease with their occasion? that *Theodora's* severity will not outlive the *Roman* cruelty? and that her heart will not be the last place, where the Emperor's cruel edicts will continue to have a fatal operation.

ALAS! *Irene*, says *Theodora*, somewhat troubled to be so pressed, how unseasonably do you now discourse to me, about things relating to a time, to which very probably my life will never reach! for, subjoins she, to deal clearly with you, I am so far from flattering myself with an expectation of those halcyon days I wish you may live to see, that I shall not be surprized, if this day proves the last I shall spend in this world; and if before night I pass thence into another, where the frailty and mortality, upon which marriage was founded, ceasing, that condition of life will have no place; but will be succeeded by an angelical state, where our friendships, as well as our persons, will be transfigured, and made incomparably more perfect, than they can be here below.

C H A P. V.

THEODORA had scarce made an end of saying this, when her conversation with her fair friend was interrupted by the notice, that was given them, of the arrival of a gentleman of their religion, who brought some news, that it concerned them to know. This advertisement soon brought back these two excellent ladies to the rest of the company, to which this intelligent and inquisitive person was going to give an account, which the sadness of his looks prepared them to find an unwelcome one.

one. However, they listened to him with great attention, as well as concern; and he, after a short preamble, briefly acquainted them with some particulars, that will hereafter be more fully related. But that, which he himself seemed most moved at the mention of, and which most affected his hearers, was this; that when the president had notice of *Theodora's* escape, though there wanted not some generous men, that endeavoured by several arguments to dissuade him from prosecuting her any further; yet he was so far from being prevailed with to comply with so reasonable a motion, that he solemnly protested, that if ever he could get this fugitive (as he was pleased to call that admirable person) once more into his power, he would never strive again to reclaim her by the fear of infamy, (a thing, which, said he, I perceived she despised) but by the terror of death; supposing, as he added, that she would not fly from an altar to a scaffold, or a stake; and resolving, in case she were inflexible, to sacrifice her to the indignation of those incensed deities she had so obstinately provoked.

THE former part of this discourse, which related to *Didymus*, his excellent mistress heard not without such inward commotions, that, in spite of the calmness and reservedness of her temper, they clearly enough disclosed themselves in her face, by several changes of colour, which those, that had lately admired the greatness of her courage, could not but ascribe to that of her concern for her distressed lover. But when the relator had concluded that part of his narrative, that directly regarded herself, though it filled all the auditors with grief and terror, *Theodora* seemed to have gained a new life; since, in her looks, the visible tokens of a deep sadness were succeeded by no less manifest signs of joy.

WHILE the rest of those, to whom the melancholy account was given, were entertaining one another with the reflections they made upon it, *Irene* having drawn her fair friend aside, was impatient to learn the cause of that pleasing change she had observed in her looks.

WHILST, answers *Theodora*, I was listening to the report of the imminent danger, which the generous *Didymus* was exposed to for my sake, I could not but be extremely troubled to find myself restrained from attempting his rescue, by the manifest danger of being by the barbarous president sent back to the infamous place, whence your virtuous friend had ventured so much to free me: but now that the judge, by a solemn declaration, has tied up his own hands from tempting me by so justifiable a fear, as that of infamy; it was no wonder my looks disclosed some tokens of a joy, grounded upon so welcome an opportunity to exercise my gratitude without hazarding my honour.

WHAT? *Theodora*! saith *Irene*, as it were thunder-struck with this unexpected answer, do you put so small a value upon that wonderful deliverance, that scarce an hour ago you did so devoutly and deservedly give thanks for, that you will so soon rush into greater dangers than those, that required little less than a miracle to rescue you from them?

I HOPE, replies calmly *Theodora*, that I shall never forget, nor without a deep sense remember, the admirable rescue you speak of. But I take the most gracious part of that deliverance to consist in my being rescued from dishonour; and think it would be much less obliging than it is, if it debarred me from the surest and directest ways to glory, and if, to preserve my external purity, it did condemn me to ingratitude towards the meritorious instrument of that preservation.

OUR lives, saith *Irene*, being trusted to us, as well as vouchsafed us, by God, are not so much at our own disposal, that it is allowable for us to part with them as we think fit; and it is possible for us to abandon them, not only when we do directly
and

and violently rid ourselves of them, but when we do those things, whose natural consequence is an untimely death.

I BELIEVE with you, faith *Theodora*, that our lives are to be reckoned among those goods, that we are entrusted with, rather as stewards than unaccountable proprietors; and acknowledge too, that certain actions, that do not directly, may yet criminally tend to their destruction. But I do not think the care of our lives is committed to us, as that of our souls is, with so indispensable an obligation to keep them, that it can never, upon any terms whatsoever, be lawful for us to lose them: for I think life to be a talent, which is indeed to be carefully husbanded and preserved; but is committed to us, not so much to keep safe, as to negotiate with; and is entrusted to us in order to a condition better than itself. And therefore, if religion, or virtue, require any thing at our hands, which cannot be performed without endangering, or even losing our lives; in that case to venture them, or to part with them, is a duty, and consequently at least a justifiable action: and this, pursues *Theodora*, I take to be my case, who am summoned by faithfulness to a just promise, and by gratitude to an extraordinary benefactor, to endeavour the saving of an innocent person, who is accused on my account, and has brought himself into a great danger, only for having most obligingly rescued me from a greater.

BUT what, replies *Irene*, if the attempt you design is far more likely to destroy you, than to save *Didymus*? For the barbarous judge is so much an enemy to all Christians, as such, and so much incensed against you, for your escape, and him for having been the author of it; that the cruelty of that inexorable man will make him gladly destroy you both, as far as human power and rage can do it; and so, without preserving to the church of *Antioch* one of its ornaments, you will deprive it of another, and a greater, by denying it the influence it might receive by so lasting and exemplary a virtue, as may justly be expected in a person so pious, and so young, as *Theodora*.

THE experience, answers *Theodora*, that this very day has afforded me, forbids me to distrust divine providence, and keeps me from despairing to find my endeavours to rescue your kinsman successful; if the most wise and good, as well as absolute disposer of events, shall not think it less our advantage to be reprieved, than crowned. Without presuming therefore to foresee events, it is my part to do what God has vouchsafed to put into my power; and it is not my duty to rescue *Didymus*, but it is to attempt it, and thereby acquit myself, as far as I am able, of what I owe to my promise and my gratitude. If I had the vanity to think, adds she, that in a person of my sex and frailties, such a church as that of *Antioch* could be much concerned, I should think too, that the attempt I am about to make, were the best way to make my life somewhat significant: for, whereas our heathen adversaries are so blinded with prejudices, that they look upon all we do or suffer for Christianity, as the effects of a kind of superstitious frenzy, that seizes us, and transports us, whenever the articles of our faith are contended for; my exposing myself to their fury, rather than be wanting to the dictates of gratitude, which they, as well as we, look on as a moral virtue, may help to convince them, that our love to virtue is general, and more disinterested, than they thought it; since Christians can venture and part with their lives, as well to shun ingratitude, as to resist idolatry.

THIS gratitude, (replies *Irene*) whose excess gives you and us so much trouble, is a relative thing; and benefits or services received ought to be requited by actions, that are acceptable to those they are designed to gratify; but sure not by such, as we know will be unwelcome to them. And therefore, (continues she) the faithfulest and most disinterested of your servants will be far more unhappy, than the *Roman*

cruelty

cruelty can make him, if what he has done doth not convince you, that he can never look upon any thing, as a favour or retribution to him, that shall destroy, or so much as endanger his adored mistress.

I WERE very unworthy, (rejoins *Theodora*) if I did not think *Didymus* capable of the highest sentiments, that generosity and friendship can inspire. But he is too just to forbid those he loves to aspire to some share of those noble qualities, upon whose account, I am to consider, not so much what his virtue will relish, as what his condition requires; there being a sort of debts, to which mine to him belong, that ought to be the more carefully paid, the more frankly they are remitted.

THE sorrowful *Irene* being exceeding troubled to see her endeavours unsuccessful on an occasion, upon which, of all others, she most wished to find them prevalent, was prompted by her grief to bring her eyes to the assistance of her tongue; and weeping, said to her inflexible mistress, If, madam, you will not have any compassion for the excellent *Theodora*, at least take some pity upon the disconsolate *Irene*; and if her arguments cannot move you, be not at least inexorable to her fears. You have, (continues she) vouchsafed me the honour of your friendship, and the happiness of your conversation; and by both these blessings have given me so much esteem and kindness for so great a benefactor, that if you deny me, what I now implore, you will turn the noblest parts of my happiness upon earth into instruments of my infelicity; since, in a world deprived of *Theodora*, the desolate *Irene* will languish, rather than live, if she should be able to survive so great a loss.

Theodora, whose resolution and good nature were both of them extraordinary, though she had courage enough to support calmly her own personal sufferings, yet she had tenderness enough to be very sensible of those of her friends. And the moving expressions of the sorrowful *Irene*, together with the tears, that accompanied them, made such an impression on her, that though, having foreseen this storm, it did not surprize her, yet it did much distress her, and let her see, how many uneasy victories she was to gain, before she could triumphantly compleat that day's work. And though after a short, but sharp, conflict, between her kindness and her resolution, the latter of them prevailed, yet it was not without some reluctance and commotion, that she was able to return this answer. Ah, dear *Irene*, do not exercise so much cruelty yourself, whilst you reproach me for being cruel; and do not add to the great affliction of parting with such a friend as *Irene*, that of seeing her so much troubled on my account, and of seeing myself necessitated to the uneasy task of denying a request of hers. If what I owe to my religion, and to your generous cousin, would suffer me, upon any terms, to alter the resolution it prompted me to; the declaration of your desire to have me do it would have made all the arguments, you employed to persuade me to it, unnecessary. It is true, that among virtuous friends kindness may challenge much, but not to the prejudice of conscience and reputation. I hope our friendship is not, and am sure it ought not to be, barely a mutual fondness of two young virgins; but that virtue had a greater share in making and continuing it, than sympathy and inclination had: and it is but just, that a friendship, grounded chiefly upon virtue, should be governed and regulated by it. Permit me therefore (pursues she) with that freedom and plainness, that our friendship allows, to put you in mind, that in the streights, wherein providence has now placed us, it calls upon us to consider, not only that we are friends, but that we are Christians too; who ought in reason, as well for our departing as our departed friends, to listen to the apostle of the *Gentiles*, who forbids us, upon the removal of those we love, to give up ourselves to sorrow, as those that have no hope. Indeed, if we were *Epicureans*, that believe the soul as mortal as the body, or such other pagans, as bury in the graves

of their friends the hopes, or at least the confidence, of meeting them again; we could scarce too bitterly deplore a separation, that would certainly, or at least for aught we know, prove an eternal one. But having, through the goodness of God, been embracers of the gospel, and enabled, though but imperfectly, yet sincerely, to live according to its dictates, and be ready to die for its defence; the same grace may keep us from fearing, that the time of our separation will be lasting enough, to bear any considerable proportion to that eternity, which will be allowed us to enjoy each others company in. And give me leave to tell you, *Irene*, that I cannot rejoice at any expressions, even of your kindness, that are injurious to your piety, and bring your love of me into a competition with that, which ought to be as unparelleled as its object is. They love a creature too much, that think it too good to be parted with for the creator's service. It is a high injury to him, to think we can lose any thing for him, that he cannot make us a rich amends for. And I must not conceal my opinion, that a Christian disparages both himself and his profession, if he complains, that any loss can make him unhappy, while he possesses the favour of God. Wherefore, my dearest *Irene*, (concludes she) let your friendship alleviate my grief, by shewing me, how handsomely you bear your own; and prefer, I beseech you, upon this sad occasion, the exercise of the more generous, to that of the more tender, effects of kindness.

ALAS! madam, says the distressed *Irene*, all the fine things you say to comfort me, produce in me an effect quite contrary to that you design by them; since they do but the more discover the excellency and kindness of the incomparable person I am going to be deprived of; after whose company I shall find that of the rest of the world too insipid, so much as to divert me: and therefore, if you will not grant me the blessing of living with you, at least do not deny me the satisfaction of dying with you. For though martyrdom be very formidable to a frail woman, yet heaven is more desirable to a Christian; and I shall not fear to take a scaffold or a stake in my way, when I travel to such a place, as that, in such company as yours.

You know, (replies *Theodora*) as well as I, that our religion commands us to suffer martyrdom, when we are obliged to do it; but forbids us to thrust ourselves unnecessarily upon so fatal and difficult a work. The apostles themselves, whose peculiar office it was to be the heralds and champions of the gospel, were commanded, when they were persecuted in one city, to fly into another; and accordingly one of the most courageous of them, to avoid needless and unseasonable dangers, fled to *Jerusalem* Act. xix. from *Damascus*, though, to do so, he was fain to be let down from the wall of this 25. place in a basket. And it is but reasonable we should not, without a manifest call of providence, venture upon a conflict, in which we do so much depend upon extraordinary assistances for the victory, that the same bold disciple, that so confidently promised our Saviour, that he would die for him, was, in an hour or two, the first that renounced him. An inspired teacher, who was ambitious to be, as he afterwards proved, a martyr, reckons it to be the gift of God, not only to believe in Christ, but to suffer for that belief. If (continues she) our conditions were exchanged, and *Irene*, instead of me, were by divine providence singled out for martyrdom, I should not envy her the glory, of letting many of both religions see, that Christianity can elevate the courage of a woman to a degree, that they think appropriated to men. I would employ my prayers rather to obtain of heaven a divine support of her resolution, than an inglorious change of it; and imitating that well-natured *Israelite*, who not only willingly, but gladly, parted with his dear *Esther*, when she went from him to a throne, I should be more satisfied with *Irene's* advancement, than with her company; and if I did not prefer her happiness to my own, it would be, because indeed I

should look upon them so united, that I should find mine in hers. Let me then (says *Theodora*) conjure you by all our past and future friendship, rather to congratulate, than lament, the remove I am going to make; and be not troubled, that one, whom you have been pleased so much to love, is called to be early happy. In such hazardous times as these, you know not how soon the persecutor's sword may send you after her; and, at most, this mortal life is too short, to let our separation be very long. And in the mean time, the comfortable expectation of an unchangeable state, of whose blessedness the renewed fruition of each other, will make a part, and not the greatest neither, may console you for the absence of a person, that in the *interim* will be happy enough to wish you where she is, upon much juster grounds, than you can wish her where she was. Let it then (concludes *Theodora*, with weeping eyes,) be a sufficient proof of my esteem and love of *Irene*, that I part from her with tears, when I am going to a place, where the divine oracles assure us, that *all tears shall be wiped from our eyes*, and be succeeded by a *fulfness of joy*, that shall last for evermore.

Rev. vii.
17.
Psal. xvi.
21.

C H A P. VI.

THOUGH these reasonings were such, as *Irene* knew not well how to answer, yet being incapable of acquiescing in any discourse, that inferred it to be her duty to part with *Theodora*, she resolved to try, whether the persuasions of the company, (which she knew would be very forward to assist her) would not be more prevalent, than hers had been: and that seemed an accident very friendly to her design, that just then happened, by the arrival of an intelligent gentleman, whom she had a while before employed to learn news of her friend; and who, on that score, had been a curious and heedful spectator of all, that had passed at the president's, in relation to *Didymus*, and was come to bring *Irene* an account of it. To hear this, she and her sorrowful friend were desirous to rejoin the rest of the company; to which the high and just esteem they all had of so brave a gentleman, as *Didymus*, gave an impatient desire to be informed of his adventures. To satisfy this curiosity, the gentleman, that was to do it, did, after a short pause, make them the following narrative.

I suppose this company needs not be informed by me of what happened to the generous *Didymus*, between the time, that the excellent *Theodora* was condemned to an infamous place, and that, wherein he had the happiness of helping her to make an escape out of it: and therefore without wasting any of that little time, whereof, I fear, we may have but too great need, I shall proceed to inform you, that when this astonishment, occasioned by this surprize of finding a young man in the escaped virgin's room, was a little over, and they had clothed *Didymus* in a habit more decent to appear in before a publick assembly; they led him away to the judge, to whom some of them related, maliciously enough, what had passed, earnestly begging justice of him against a person, who (they said) could not but be a Christian; and who was not content to be himself an offender against the laws, but had dared to rescue another offender from the punishment, to which they had doomed her.

AGAINST this charge, the undaunted *Didymus* being asked, what defence he had to make, addressing himself to the judge, made this resolute answer: I stand accused of a twofold crime, of being a Christian, and of *Theodora's* rescue: and though I cannot so soon have forgot, how heinous my accusers have endeavoured to make them appear, yet, instead of denying either of them, I shall own, that I glory in both.

As for Christianity, in an age, wherein it is so cruelly persecuted, I would not have embraced the profession of it, but that I was resolved, if there were occasion, to suffer for it. And therefore I shall neither deny what they call a crime, nor make an

apology for it, nor deprecate any infliction, (for so I call it, rather than punishment, which still supposes a fault) whereto it can expose me. Nor could I, without being wanting to the duty of humanity, refuse my assistance to preserve the purity of so noble a shrine of chastity, as the savage designers of a rape on *Theodora* were going barbarously to violate. And the inward satisfaction of having done what became me on such occasions, will support me under any sufferings, that shall be drawn upon me, but by my loyalty to persecuted truth, and my compassion of distressed virtue.

THE experience I have had, (answers the president) of the effects of those desperate errors you miscall religion, makes me inclinable enough to think, that you, as well as many others of your wild sect, have both madness and impiety enough to put off the apprehensions, as well as the other common sentiments, of human nature, and fear death, as little as you do the Gods. But since you pretend to be more virtuous men, and obedient subjects, than others, pray tell me, what you can say, for rescuing a malefactor out of the hands of those ministers of justice, that were going to execute the sentence of condemnation upon her?

IF, replies *Didymus*, the sentence you speak of had doomed her to death, though I should most gladly have suffered it in her stead, yet I had deplored your cruelty, without attempting to defeat it. But I confess, I could not, without indignation, as well as grief, see such a person as *Theodora*, who for her beauty, virtue, and other perfections, is justly admired by all that know her, and looked upon as the honour of her sex, most injuriously condemned to so infamous and barbarous an usage, as were unfit for the meanest and despicablest of creatures, that belong to the sex, whereof she is the ornament. And considering with myself, that chastity in women, and especially in virgins, is so much a virtue, and their right to preserve it so confessedly inherent, that all nations agree in ascribing to them a right to defend it, without reserve, against whosoever attempts to deprive them of it; I concluded, that to help a distressed virgin to preserve so acknowledged a right, was to defeat ravishers, rather than to oppose magistrates, and not commit a crime, but hinder the accomplishing of one. Nor could I think, that it was against the Roman judges I acted, when I opposed persons, whom their savage design made me look upon as the worst sort of Barbarians. And I did not doubt, Sir, (continues *Didymus*) that in your own breast, when calmer thoughts shall come to succeed those, that lately possessed it, I shall be absolved from an action, which kept you from dishonouring yourself as much, as the execution of your sentence would have defiled *Theodora*; and kept you innocent as to act, from what would have made you enemies for ever, not only of the fairest half of mankind, but of all those of our sex, that retain any sparks either of virtue or good nature.

IF *Theodora*, (replies the president) were not a beauty, and one of your obstinate sect, I doubt you would never, for her sake, have adventured upon so desperate an attempt, as makes you not more disobedient than obnoxious to the law.

I SEE not, Sir, (rejoins *Didymus*) why it should be a disparagement to *Theodora's* beauty, or to the impressions I have received of it, that all, that it has engaged me to do, has been, with the utmost hazard of my life, to rescue her purity, and deny myself, in the first place, the advantages I endeavoured to deprive others of. But the charms of her mind needed not those of her face, to make me attempt to preserve her. I have often in camps contended, not without hazard enough, with my victorious fellow-soldiers, to keep them from violating the chastity of captives, who had neither beauty to captivate others, nor any thing else to engage me in their quarrel, except their being innocent and distressed women. But *Theodora*, setting her beauty and birth aside, has been so eminent, for all the good qualities and excellencies, that can accomplish a person of her sex, and especially for her chastity, that my heart

1 John iii.
16.

would have reproached me for not prizing virtue enough, if I had declined so happy an opportunity, to express the veneration I paid so shining a one, as hers. But, (pursues *Didymus*) I would not, by what I have said, be thought to deny, that my religion had a share in the attempt I made to serve a person, that did so much adorn it, and was so loyal to it. The Christian doctrine, among many other excellent things, that it prescribes to its embracers, teaches them, that in some cases, among which ours is comprized, they *ought to lay down their lives for one another*. But, Sir, (concludes *Didymus*) you may be pleased to take notice, that what I acted was according to the rules of it too: for I did not oppose the execution of your cruel sentence by force, but only prevented it by an innocent stratagem, whereby my ends were obtained without bloodshed or violence; no man's life having been so much as endangered, except my own, which I never thought myself bound to preserve from any danger, that piety or humanity summoned me to undertake.

THOUGH the president could not but be sensible, that *Didymus* had said more for himself, than was expected; yet, that he might not be thought to be satisfied with the defence of a person, whom he meant to condemn, he told him; I do not think it strange, that those, who dare call the very worship of the gods superstition and idolatry, and that, which all men but yourselves call impiety, religion, should style rebellion against the magistrate, loyalty to the truth. But how industriously soever you strive, not only to cloak a criminal action, but transform it into a virtuous one, I can easily, through all its disguises, perceive the disobedience and refractoriness to civil government, that is so contagious, and so spread among the embracers of your sect, that princes have no other way, but your ruin, to secure their own safety, which would be quickly endangered, if your power and numbers were half as great, as the disloyalty of your principles and practices.

To be a sufferer for my religion, (answers *Didymus*) is that, which I shall not so properly submit to with resignation, as embrace with joy: but to find my religion a sufferer with me, if not for me, and to see Christianity made a state-crime, while it severely prohibits and condemns all crimes, and none more expressly, than disobedience to the just commands of magistrates, is that, which I confess, does not a little trouble me; and therefore, Sir, I hope you will allow a person, that is much more concerned to keep his religion, than himself, from being endangered by this accusation, to give you a righter apprehension, than our calumniators have done, of the innocentest, as well as the truest, religion in the world.

THOUGH, for my part, (continues *Didymus*) I think, that the liberty of serving God, by such ways, as are not repugnant to the light, or laws of nature, or the welfare of civil Societies, is the common right of mankind, and cannot be denied man, without injustice; yet I do not now plead for it; and you are more concerned to look to that, than I. For if you make me suffer, for the innocent use of that right, which God and nature have granted unto all men, I shall but undergo a transient punishment; but you will expose yourself to an eternal, and (which is worse) to a deserved one. No persons in the world can pay more obedience to the laws of their superiors, than Christians do. We, that can shed the enemy's blood, and hazard our own, as freely, and perhaps as successfully, as any soldiers in your armies, suffer you to shed ours, as tamely as any sheep you have in your folds. And sure, we are very unhappy, as well as you very incredulous, that those professions of loyalty and obedience, that are not more visibly written in our books, than frequently signed with our blood, cannot gain credit with you; nor our death itself convince you, when the wounds, that we quietly suffer to pierce our breasts, would open you windows into our hearts, if some had not a greater mind to pierce them, than to know them. But the same just care

we.

we have to obey authority, what rate soever the submissions cost us, forbids us to do those things, for the refusal whereof authority condemns us. For God being, as the only creator, so the supreme governor of man, his laws are those of the truest supreme authority: and princes themselves being his subjects, and but his lieutenants upon earth; to decline their commands, whenever they prove repugnant unto his, is not so much an act of disobedience to the subordinate power, as of loyalty to the supreme and universal sovereign. And in such cases we are no more rebels against the emperor, when we prefer the performance of God's laws to a compliance with his, than we should be, in case we should disobey the orders of the governor of the province we live in, if they should prove repugnant to those of *Augustus*. And even in these cases, if we cannot yield an active obedience to the commands of the civil sovereign, we do not refuse him the utmost we can consent to, which is passive obedience: and when our consciences permit us not to do those, to us, unlawful things, that he commands, they enjoin us to suffer unresistedly, whatever penalties he pleases to impose. And give me leave, Sir, to add, (so *Didymus* continues) that we are so far from making religion a cloak to the pursuit of present advantages, that you daily see us renounce them all, and our lives to boot, to maintain our loyalty to our maker, without hopes of being recompensed, but in another world; and even there we cannot expect any, but by the sentence of a judge, whom none can either bribe or deceive, and who is more severe to crimes, than any persecutor on earth can be, to innocents. I will not tell you, pursues *Didymus*, that, on the other side, the assurance we have of the inestimable rewards laid up in heaven for loyalty to God and his truths, the internal applauses of a good conscience, are things of so elevating and satisfying a nature, that our religion can make the hearts it possesses, not only detest the ambition of those subjects, that aspire to earthly crowns, but perhaps pity the condition of those princes, that possess them. But I dare, Sir, avow, that the harmlessness of our principles is not more legible in our profession, than in our practices and sufferings. For the multitude of Christians is so great, that [in your cities, your country, your courts of justice, your camps, and all places of publick resort, except your temples, they are not only present, but numerous;] and your enemies, as well as your armies, have been sufficiently convinced they know as well, how to kill, as die: so that it is only because we will not forfeit our innocence, by a forbidden way of defending it, that we are exposed to such cruel sufferings for it. And I doubt not but equitable estimators of things will conclude, that our calmly submitting to such inhuman usages sufficiently shews, that we do not deserve them. *Tertul.*

THE judge discerning still more clearly, that his discourses made much less impressions upon *Didymus*, than those of *Didymus* did upon the hearers, resolved to break off this kind of conversation, and with a stern countenance, told the prisoner, that it was high time for him to remember, that he was a judge, and not a priest; and that therefore, though his compassion had hitherto invited him to employ persuasions, yet now their unsuccessfulness obliged him to declare positively, that he was sure the gods, that he and the world worshipped, were the true ones; and that if *Didymus* did not forthwith acknowledge them to be so, by sacrificing to them, he should quickly feel their power, by being put to a death, his obstinacy made him both deserve and appear fond of.

DIDYMUS, without seeming to be at all moved at this rough language, calmly, as well as resolutely, replied:

THOUGH, Sir, I am most ready, whenever I am called to it, to suffer for my religion, yet I would not be thought to expose myself, for an obstinate denial, to hear and consider, what may be objected against it. We Christians, whatever wilfulness may be
misimputed:

misimputed to us, are not so fond of sufferings, or of our own conceits, as not to be more willing to have them brought to the bar, than to be condemned there for them: and persecuted opinions are things, which, as we do not renounce, so we do not embrace, for their being such. Nor are we so blind and wilful, as to reject clear arguments, that would both instruct us and rescue us too, if any such could be proposed by the embracers of your religion.

THIS I say, Sir, continues *Didymus*, not to contradict what you were saying of your being not a priest but a judge; but to clear constancy from the imputation of obstinacy, and declare, that if we could see reasons on your side, fitted to deliver us from error and from death, we would not be so mad, or so perverse, as to chuse rather to renounce life, than embrace truth. But pardon me, Sir, (subjoins he) if I think, that though you are commissioned by the supreme power to be a judge for life and death, yet you are not constituted by the supreme verity a judge of truth and falsehood: and therefore, I take your owning to worship many gods, who, by their very being many deities, are sufficiently proved not to be true ones, for a declaration of your opinion, not a demonstration, that it ought to be mine too. If you press us with arguments, we are ready to answer yours, and offer you ours: but when, instead of them, you employ threats, we do not think it proper to argue against them, but to despise them; since it is not our reason, that they assault, but our constancy. And therefore, give me leave to tell you, Sir, concludes *Didymus*, that the Christian religion can so fortify and elevate the mind, and place it so much above the reach of a political jurisdiction, that I shall suffer your sentence with far less trouble, than you will soon or late feel at the remembrance of your having pronounced it; and you will not find it in the power of all your executed threats, to ruin either my constancy, or so much as my joy.

THE judge, enraged to see his power thus despised, and, as he interpreted it, affronted by a prisoner, declared, he would defer no longer than one hour (which space he allowed him to repent his errors in,) to pronounce against him the fatal sentence, and commanded him to be immediately led to the place, where it was to be executed; towards which he himself intended to follow at some distance; whether it were to feed his cruel eyes with a spectacle, whose tragicalness his revenge would make acceptable to him; or to prevent any tumult or disorders, that the courage of *Didymus*, and the esteem and pity it had excited in the numerous by-standers, might possibly occasion.

C H A P. VII.

AS soon as the gentleman, that made the past discourse, had ended it, the just idea it formed in the minds of the hearers, and especially of the two ladies, of the singular piety and heroic courage of *Didymus*, made such an impression on the grateful and compassionate *Theodora*, as exceedingly heightened her resolution to rescue him, if it were possible, and hastened her to begin immediately to attempt it. In order to which, having observed, that the hearers listened so attentively to what the relator said, that they then minded nothing else, she took that nick of time to withdraw herself silently into another room, and by a pair of back-stairs, conveyed herself out of the house; whence by indirect ways, (for fear of being overtaken in the shortest,) she went with as much haste and gladness to an almost certain death, as others are wont to shun and escape it with; leaving *Irene* and her other friends, no less amazed than troubled, when sometime afterward they perceived her missing, and found all the diligence they employed to retrieve her fruitless: for, *Theodora*, fearing she

she could not long escape the diligence of her pursuers, unless she hastened to a place, where she justly thought they would not follow her, delayed not to go directly towards the company, that she was told attended the president in the affairs, that were transacting in his court. Among these attendants she had not staid long before she descried her brave lover under a strict and rude guard, but with a look so manly, and so serene, as shewed, that he deserved another usage, and was not in the least daunted nor discomposed by that he met with. This moving sight so affected the generous and compassionate *Theodora*, that though in so publick place and manner she could with less reluctancy die for *Didymus*, than she could plead for him; yet her gratitude surmounting her bashfulness, after some conflict within herself, she made towards the tribunal, to which she found a more easy passage than she expected; for the advantageousness of her shape and stature, and gracefulness of her motions, easily produced for her such sentiments in the admiring by-standers, as made them with great respect give her way, and let her, without disturbance, pass on to the bar. She had but a very little while staid there, before the president was moved by the concurrence of those, whom curiosity and wonder invited to gaze on the fair stranger, to cast his eyes on her; and notwithstanding the unlikelihood, that she should appear there, without having been forcibly brought thither, as soon as, out of respect to his dignity, she had lifted up her veil, he discerned, that it was she, by a sort of beauty so peculiar, as was not easily either to be met with in others, or to be forgotten by any, that had ever seen it.

BUT though the judge were thus surprized at her presence, yet he little less admired her courage, than her beauty, when, with a face, wherein the blushes of her cheeks, and the assuredness of her looks, equally discovered her modesty and her fearlessness, she told him, I know, Sir, that it is a very unusual thing, for a person of my sex and religion, to come to this place unsent for: but I hope you will be pleased to consider, that, as the action is extraordinary, the occasion of it is so too. For both virtue, the justice, that you sit here to distribute, and gratitude founded upon the highest obligations, engage me to appear before you on the behalf of that brave prisoner, (at which words she pointed at *Didymus*,) and present you the object, on which you may inflict with legal justice, what you cannot make him suffer, without being taxed of cruelty. For supposing a debt to be due to the law, yet it would be more severe, than just, to prosecute the security, now the principal offers to pay the debt. He may well be looked upon as my hostage, whom I now come to redeem; and it is not, Sir, your interest to decline the exchange, since by it you will preserve a person, whose courage, engaged by his gratitude, may do signal service in the Roman army; and since my escape was all his crime, I beseech you let my surrender of myself obtain his absolution.

HERE *Theodora* paused a while, partly to recover from the disorder so unusual and difficult an effort of her modesty had put her into; and partly to observe the judge's countenance, upon his hearing, what she had said, and to take measures thence, in what she was further to speak. The president in the mean time continued silent, whether the longer to hear the music of her voice, or because so many charms, as nature had crowded in her face, and so much sadness, as her concern for her lover had displayed in her looks, had somewhat mollified him, as they might have done a tiger. Whereupon the fair suppliant hoping, that his not interrupting her proceeded from some relenting thoughts, resumes her discourse in these terms: but if, Sir, to procure the dismissal of this gentleman, your justice had need to be seconded by your clemency, perhaps you never had, nor never will have, an object, whose merit may so well warrant the exercise of it. For his life, ever since he bore arms, has been employed

ployed in the service of his princes, and fearlessly hazarded for their greatness. And the action, for which he is now in trouble, is so heroick, and so disinterested an one of courage and compassion, that in it he could scarce have any other motive, than the greatness of his generosity, nor other end, than the exercise of it. Nor need you fear, that your clemency on this occasion should introduce a bad example; for this of *Didymus* is never like to be imitated, nor can be so, but by persons too virtuous to be delinquents: and if such actions be criminal, at least it is unlikely they will grow common crimes. And here *Theodora* perceiving, that the impatient *Didymus* (now come again to himself, after the astonishing surprize this adventure gave him) was upon the point to interrupt her, she thus prevents him. And you, brave *Dydimus*, forbear to oppose the accomplishment of my just desires. The course, that I now take, is the only, that I could take, to evidence my gratitude, and to let you see, that you have not exercised the noblest acts of generosity and friendship towards a person insensible of the dictates of those virtues. I could not (continues she) but be glad to be rescued from the ignominy of a rape; but I did not intend to be robbed of the glory of suffering for Christ; which is also the only means left me to evince, that I declined dishonour, and not death, and never meant so much to disoblige the world, as, for the sake of an insignificant maid, to deprive it of one of the most generous of men. You have left yourself but one way to increase your past favours, which is, to allow me the only real expression I can make of my sense of them; and that in such a way, as can at most but make some little diminution of them, without pretending to make a retribution for them. If therefore (concludes she) you will compleat the obligation you have laid on me, by preserving to me the coronet of virginity, you must not oppose my obtaining the crown of martyrdom.

DIDYMUS had need of all the respect, that he paid his admirable mistress, to keep him thus long, from interrupting a discourse, that tended so little to his satisfaction; and therefore she had no sooner put a period to it, than (with a deep sigh) he told her; Cease, *Theodora*, cease, to plead for the continuance of life, that you are almost as cruel to me, in thus endeavouring to preserve, as you are, in thus hazarding your own. And if I durst not hope for, from the president, more than I see I must, on this occasion, expect from you, I should think myself as perfectly wretched, as (whatever your intentions be) your proceedings are unkind. But I am confident our unbiassed judge is too impartial, not to discern in your discourse, that the excess of your goodness has had the chief interest in the management of your plea; the case, about which we differ, being in itself so clear, that alone to state it, is sufficient to plead it on my behalf. For I enticed you to escape out of prison, and then, at my own peril, facilitated to you the means of doing so: you leave me behind as a pawn to the laws, and these, finding me in your room, make their great minister, before whose tribunal we stand, doom me, for your offence, to the death designed for your punishment; which since I joyfully proffer myself to suffer for you, or rather, since you suffer it in me your proxy, the illustrious president is too well acquainted with his office, to need to be told, that, at least in equity, the surety's payment discharges the principal from the debt; especially, when he not only proffers the payment, but most earnestly desires the acceptance of it, as a great advantage to him. I hope then, great Sir, says he, (turning himself to the president, with additional respect to that he had shewed him before,) that you will accept of my life instead of hers, who deserves a long and happy one; and that, when my sentence of condemnation shall be pronounced, and gladly acquiesced in, it may free her, I am condemned for. The love of self-preservation is so natural, that it cannot be made capital, without affronting nature, and punishing as well, what men are, as what they do: and the love of purity and honour does so much become a chaste virgin,

virgin, that the natural consequences of it are too commendable to be fit to be made penal. It is I, who having despised dangers, that I might easily have avoided, when it was question to do an illegal thing, do yet glory in the crime, that am the just and proper object of the rigour of your laws: and her years are yet so tender, and her disposition so innocent, that since, if she have erred, it was by my persuasions, if she be to be punished, it should be in my person. All that she has since alledged to appropriate my guilt, or involve herself in it, will, I hope, by a Roman magistrate be looked on, as it is indeed, as an argument of her generosity, and not of her crime. And the Romans are too much friends to gallantry, to punish in a lady that virtue, that they applaud and crown even in soldiers.

BUT now, continues *Didymus*, I must address myself to you, O *Theodora*, and must complain of, or at least deplore, my infelicity, that after I had done and suffered all that I could, though it was much less than I would, for the preservation of so dear a life as yours; you come now to hazard it, to make mine end with sorrow. But granting you should prevail in the no less unwelcome, than generous attempt, you are pleased to make, how cruel were you, to envy me at once, the two highest honours, that my ambition aspired to; the glory of martyrdom, and that of *Theodora's* rescue! Had I as many lives as you have virtues, I should esteem them all but a cheap ransom for a few hours of yours; so unlikely I am, and ought to be, to be either capable or desirous of being preserved by your suffering for my actions. And therefore, madam, if you think my little services deserve some recompence, since my highest contentments on earth terminate in your happiness, there is no other way left you to reward them, but the care of your own preservation; it being the only return that I expect or desire of my services, that you will not, by your inflexibleness, finally make them fruitless; but be content to live for his sake, that will rejoice to die for yours.

ALL the while this noble dispute lasted, the judge was, though not an unconcerned, yet a silent hearer of it; the strange novelty of the contest, and no less extraordinary generosity and gracefulness of the contenders, having given him an attention that kept him from interrupting them. But, when their debate had proceeded thus far, his stern nature, whose actings had been but suspended by his curiosity, prompted him to tell the generous couple; I know not what presumption makes you plead, as if each of you were the other's only judge, and had the supreme authority of condemning or absolving you; and I were only an unconcerned auditor, or at least sat here to ratify the sentence you shall agree upon between yourselves: but you will quickly find to your cost, that the Roman laws and magistrates are not to be trifled with.

GREAT sir, replies *Didymus*, you much misapprehend our conduct, if you think yourself slighted by it: for it was not want of respect to your authority and power, that made us discourse as we did; but a supposition, not injurious to you, that you would in the exercise of that power manifest, that you deserve it, by tempering it with two excellent virtues, that best become a magistrate, equity and clemency. This presumption, sir, and not any disrespectful one, was that, upon which we proceeded in our discourse; still taking it for granted, that you would not punish two, for that, which was indeed but the fault of one; and that if either of us were, by the other's consent, to suffer, your equity, or your clemency, would prevail with you to release the other.

THOUGH *Didymus* had worded what he said so cautiously, that a discerning hearer might perceive, that his expressions related to the judge's dignity, not his person; yet that self-flattery, which is but too common an attendant on men in power, making

the president take all these respectful words to himself, made him allow *Didymus*, without interruption, to proceed in his discourse, and say; You will easily grant, sir, that goodness, whereof clemency is a noble part, may bring a magistrate, who is heaven's vicerent upon earth, as high a veneration, as power or greatness does; if you please to consider, that those of your religion, when they would with the most deference speak of God, give the title of most good the preference to that of most great, styling Him, as the Christians likewise often do, *Deus optimus maximus*. Certainly, clemency is never more a virtue, nor less grudged at by justice, than when it is exercised towards virtuous persons, by rescuing them from the persecutions of fortune, and the unintended rigour of the laws. I say unintended rigour, says *Didymus*; for I cannot think, that the Roman legislators, that have honoured injured chastity so much in *Lucretia*, and encouraged gallantry and other virtues, by no less than crowns and triumphs, meant to make the productions of chastity, constancy, and gratitude, criminal things. And though Christians dissent from others in matters of religion; yet those moral virtues, that were so esteemed by the Romans, do not lose their nature, when practised by Christians: and those brave men, whose love to virtue made them masters of the world, did not scruple to honour it in their very enemies; and did it so much, even in the most irreconcilable of them, that more than one or two statues of *Hannibal* were erected at *Rome*; to which triumphant city it is perhaps more glorious to have thus honoured him, than vanquished him. And sure they, that thought *Lucretia's* chastity merited so many statues, would not think that *Theodora's* deserved a stake or a scaffold. This lady's actions and mine are not so heinous, but that in happier persons, and milder times, they have been looked on under a notion very differing from that of criminal ones. But sir, continues *Didymus*, addressing himself to the president in a very humble manner, if there must needs be offered up some sacrifice to appease the angry laws, I beseech you to let their rigour be satisfied with my blood, and spare this harmless lady; to whom, if your compassion be needful, I hope you will not want it for an object, whose excellencies cannot only make it reasonable, but meritorious. For it will preserve to *Antioch* its fairest ornament, and a life so exemplary, that to give it an untimely period, for actions, which, being laudable in their own nature, nothing but a rigid interpretation of the law can make criminal, would be to make the laws a terror, rather to the good than to the wicked. It would be thought inhuman to treat her as a delinquent, whom you may justly wish your daughters should resemble; when by the grant of what I implore, you will be sure to receive both the thanks of her sex, and the applause of ours, and, what out-values both, the satisfaction of having saved and obliged one of the most admirable persons in the world.

DIDYMUS, now perceiving that the person he pleaded for was preparing herself to interrupt him, re-addressed himself to her, and told her; Do not, madam, I beseech you, require of my obsequiousness proofs inconsistent with my love; and add not to my infelicity, by putting me in so uneasy a condition, as to find it my duty to oppose your desires. Ah! refuse not to oblige the world, by preserving the most accomplished it can glory in: deny me not the satisfaction, whereof I am so ambitious, of being the happy instrument of your deliverance; and then I may say, that I never could justly die more seasonably than now, when, being at the height of all my joys, my longer life must of necessity give an ebb to my felicity; since, after the glory of having saved *Theodora*, I hope for no higher on earth, than that of dying for her. Then, perceiving her ready to renew the contest, he told her, (with a low voice, that the judge might not hear him, and with a sadness in his looks, which she, that knew his courage, could impute to nothing but his almost boundless concern for her)

Madam,

Madam, though the president's impatience did not call upon us to conclude our contest, yet my condition and resolution ought to put a hasty period to it. For, madam, I must positively declare to you, that it would be as bootless as cruel, for you to think to protect my life, by the abandoning of your own; since to owe a life to that cause, would make it not only uneasy but insupportable to me, and consequently incapable of lasting: so that enjoining me to survive you, would condemn me to a life, which, after the loss of yours, must be spent, if it could last, in fruitlessly deploring that loss. Forbear therefore, concludes he, I most earnestly beseech you, madam, to exact such proofs of my obedience, that it is as little in my power to give you, as it ought to be in your will to require them; since for *Didymus* to survive *Theodora*, is as great an impossibility, as it would be an unhappiness. O admirable contest! where the noble antagonists did not strive for victory, but death; or endeavoured to overcome each other, that the victor might perish for the vanquished: where self-love, the most radical affection of human nature, is sacrificed to a love equally chaste and disinterested; and where virtue makes each of the contenders ingeniously solicitous to appear criminal, that the antagonist may be treated as innocent. How well does this proceeding prove that inspired sentence true, that *love is stronger than death*; since, in this conflict, the generous friends are by the former made rivals for the latter!

C H A P. VIII.

THE afflicted virgin, to whom these moving things were said, finding, that she should but lose her dissuasions on *Didymus*, thought fit to address herself once more to the president; and with humble gestures, accompanied with looks, and with a voice, that would have softened any, that were not invincibly obdurate, she told him, Though, Sir, the arguments used by this gentleman had far better proved than they have, that of us two, he is the fittest person to be condemned; yet I hope, where you preside with so much authority, he will not fare the worse for being generous; and that what he has done, will be more prevalent with you, than what he has said. Ever since he was capable of bearing arms, he employed them in the service of the Emperors; and in their camps cheerfully followed the Roman eagles, wherever they durst fly: and after his having this day hazarded himself so generously, out of compassion to a distressed virgin, what examples of gallantry may not be expected from such a courage, engaged by his gratitude, when he shall act for the acquirement of glory, and the service of his country? If a guilty intention be necessary to make an action so, his will not be found to be criminal; since he did not intend the violation of any law, but to second, what we are told to be the design of all just laws, which is to protect the innocent, and encourage virtue. But, if by a rigid interpretation of the law, he may be brought within the reach of it, I hope his misdemeanor will not appear so great, but that your clemency may allow him all, that I beg for him, which is, that he may be permitted to repair a mistake in the exercise of his virtue, by the continuation of those services in the Roman army, which will be far more useful to the public, than his death, in his present circumstances, can be. To this *Theodora* would perhaps have added, (though she could scarce have done it, without some reluctance from her modesty) The things, Sir, that he has been pleased to act and hazard for me, may persuade you, that if, contrary to my prayers and hopes, you should design severity towards him, you may more severely punish him by my death, than by more immediate inflictions on him. And it is like she would have enforced her arguments and entreaties for a person, for whom she was so much and so justly concerned,

cerned, when the president, vexed to find, that both of them so little valued life, whose deprivation was the most formidable thing he could threaten them with, prevented her, by saying, with a stern countenance, No, I will hear no more, having heard but too much already. It does not become a Roman magistrate to suffer any longer with patience, that prisoners and criminals should daringly disobey the laws, slight all their threats, and glory in their violation. What each of you has said to prove himself guilty, affords abundant reason to condemn you both: wherefore, since you cannot agree among yourselves, I will be your umpire, and give both of you what each desires and merits. You, obstinate maid, says he, turning to *Theodora*, shall die for having broken prison; you disobedient soldier, says he, to *Didymus*, shall die for having persuaded and furthered her escape: but to specify your chiefest crime, than which there needs no other, nor can be a greater, you both shall die, because you are Christians, and consequently enemies to the Roman Emperors, and the gods, that made them so.

THIS fatal doom being pronounced, the judge ordered the condemned prisoners to be taken aside, and strongly guarded, till all things were in readiness for their execution; which preparatives he gave order to hasten: yet finding by the discontented looks, and confused murmurs of the by-standers, that the charms and innocence of *Theodora*, and the youth, courage and friendship, of both the no less generous than unfortunate prisoners, made his sentence to be far less liked, than were the persons and behaviour of those it passed upon, declared, that whilst he was dispatching other public business, he permitted any, that should have charity enough to make a hopeless attempt, to endeavour to convert those obstinate miscreants; adding withal an intimation, that even they might speed in their suit, if they would seasonably, with incense in their hands, flie to the altars of the gods, and humbly implore of them pardon and safety.

THIS respite, as it exposed the generous couple to have their constancy assaulted by infidels ambitious of making such illustrious persons proselites, so it gave them the welcome opportunity of interchanging some discourse with one another.

THESE conferences were begun by *Didymus*, who seeing himself upon the point of final separation from his admirable mistress, could not forbear feeling in himself such disorders, as, on all other sad occasions, his great courage had kept him from resenting: and this unusual commotion of mind, was uneasy enough to oblige him to say, to the fair person, that occasioned it, Though, madam, the military course of life I have with some forwardness pursued, has accustomed me to meet death in variety of formidable shapes and dresses, without being discomposed by it; yet when I see the world going to be robbed of its noblest ornament, and myself to be deprived of the person I most love and admire in it; and when I see this matchless person ready to be ravished from us, both in the flower of her age, and by the infamous hand of an executioner, I think it were rather stupidity not to be afflicted, than any weakness to be deeply so.

I WAS, answered *Theodora*, so fully satisfied before of your friendship and compassion, that this new grief of yours, as it is a very needless proof of them, so it is a very unwelcome one: for, if I were to allow any thing to grieve me, when I am entering into *the fulness of joy*, it ought to be, that I find your good-nature renders this seemingly distressed condition of mine very uneasy to you, which, through God's assistance, is very little so to me; and yet will be less so, if, congratulating rather than deploring our martyrdom, you will ease me of the justest and greatest part of my grief, that consists in being unhappily accessory to yours, and seeing you needlessly troubled at mine. That circumstance, adds she, of my death, which I perceive much afflicts

you,

you, might, in my opinion, more justly lessen, than aggravate your sorrow: for I look upon it rather as a favour, than an infelicity, that I am early removed out of the world, where I see, and suffer, and (which is worst of all) do so much ill. To be early rescued from the snares of a dangerous and persecuting age, and preserved *from the evil to come*, is rather a privilege, than a calamity, to those that are duly sensible, as I desire to be, that one can never arrive unseasonably at heaven, nor be too early happy. And, in this persuasion (continues *Theodora*) I am confirmed by considering, that the first of those, who are recorded to have religiously deceased, in the old testament, and in the new, just *Abel* and *John the Baptist*, both of them died young, and perished by the hands of those that persecuted them for their piety: and even that spotless Lamb of God, *who did no sin*, but by his satisfaction, precepts, and example, *takes away the sin of the world*, was sacrificed almost in the flower of his age; so little is it an unhappiness, or a mark of God's disfavour, to escape the toils and dangers of a troublesome navigation, by an early, though by a boisterous wind, blown into the port. And if it could become a woman to encourage a hero, I should exhort both you and myself too, generous *Didymus*, (continues she) to entertain our present condition with sentiments becoming Christians. And, as it does not trouble me directly, so it ought not to trouble you upon the score of sympathy, that I am secured from the hazards and inconveniencies of age; but be pleased to make use of that courage, now at the end of your days, that you have constantly expressed in the course of your life; and do not, I beseech you, repine, either that you or I is to fall by the hand of an executioner: for that seeming, and but seeming ignominy, was the lot both of our Saviour's immediate harbinger, and of our Saviour himself; and when we consider for whom, and for what we suffer, we may find reason enough to assume the sentiments of the apostles, who, after having been misused by the Jewish council, *went from their presence rejoicing, that they had been thought worthy to suffer for his name*; for whom we are going to suffer the like things: for, *Didymus*, God's gracious providence has not left us to perish, by lingering or tormenting sickness, or troublesome old age, nor yet for some common cause, or some unimportant end; but all in our fate is noble; and what to others is meer death, a debt due to nature, or the punishment of sin, to us is martyrdom, the noblest act of Christianity, and shortest way to everlasting glory.

Acts v. 41.

A DISCOURSE, that relished so much more of a martyr than of a virgin, gave *Didymus* a rise to continue a conversation, by which he found himself as well assisted as charmed; and therefore observing the serenity of his mistress's looks to be little inferior to the beauty of her face, and remembering what instances she had that day given of an altogether extraordinary piety and courage, was, by the sentiments these reflections produced in him, prompted to tell her; I should be justly inconsolable, madam, to see myself and the world upon the point of being deprived of so admirable a person, as *Theodora* has, by this day's various trials, manifested herself to be, if I were not confident, that my loss will be as short as great; and that, in the state we are now entering upon, I shall be allowed what approaching death will deny me in this, and shall find in heaven the endearing happiness of conversing with her more freely, than our persecutions and her reservedness would here permit. For, madam, (continues he) I am friend enough to my own felicity, to believe assuredly, that those, who shall be happy enough to meet in heaven, will know one another there, and have their joys heightened by the remembrance of what past between them upon earth. For, in the blest state we are hastening to, our faculties, and consequently our memory, will not only be gratified with suitable objects, but be improved by enlarged capacities; and even in a condition short of that we this day expect, men's knowledge has been advanced,

advanced, at least as much as is necessary for our knowing one another, without the helps, that are ordinarily requisite to make us do so. As soon as ever *Adam* saw *Eve*, he could confidently say of her, that *she was bone of his bone, and flesh of his flesh*. When *Noah* awaked from his sleep, he could tell, that during his sleep, his younger son had behaved himself irreverently towards him. When our Saviour was transfigured on mount *Tabor*, the three chosen disciples, that attended him, presently knew *Moses* and *Elias*, whom they had never seen before, in spite of the disguise, that the glory they appeared in put upon them. St. *Paul* tells his Thessalonians, they shall be his joy and crown, before their common Lord: to the truth of which it seems requisite, that both the preachers and the converts shall be publickly known at that great appearance, and *assembly of the first-born, whose names are written in heaven*; and consequently, that men there shall know one another. Our divine Redeemer, continues *Didymus*, teaches us, that there is joy in the presence of the holy angels over a repenting sinner; which argues, that whether they know of his conversion in a more intuitive way, or by the information of those angels, that are sometimes sent to this lower world about human affairs, they yet have a knowledge of particular persons, and take notice of particular things, that concern them. And, which makes exceedingly for my present purpose, he introduces *Abraham* in paradise, calling upon the uncharitable rich man to remember what his own and *Lazarus's* differing states had been upon earth: and, which is yet more, to shew, that even in the place of utter darkness and torment, the memory of past things and persons is not obliterated; the rich man is introduced, as remembering not only *Lazarus*, but his own five brothers, and their dangerous condition.

THE pause, that *Didymus* made after these words, invited *Theodora* to tell him, Since, generous *Didymus*, I have observed our soundest teachers to be of differing opinions about the subject of your discourse, and that they do not look upon it as an article of faith, either that the blessed do, or that they do not, know one another in heaven; I presume I may be allowed to think, that if they do, (which I know is the most received opinion) they do it in likelihood with other sentiments, than we commonly imagine. For when the beloved disciple teaches, that, though *we be here the Children of God, it does not yet appear what we shall be*; and adds only in general, that, *when our Saviour*, or that blessed state, *shall be manifested*, we shall be like him: when, I say, I reflect on this, and some things of the same import, I am prone to fear, that we judge too much of our future glorious state, by wrong measures taken from our present frail and mean condition. And I am apt to think, that we must stay till we come to heaven, before we shall frame ideas suitable to the prerogatives of its blessed inhabitants. I think our notions will then be raised, as well as our dust, and our love, and other affections, will be transfigured, as well as our bodies. If we know one another, though our mutual love may perhaps be greater than it ever was on earth, yet it will not be upon the former accounts, but will be as well better grounded, as better regulated. That external beauty, pursues the fair speaker, that here is so much doted on, and over-valued, will there be found so much inferior to that of every glorified body, that the difference and degrees of it will be very inconsiderable, and unable to make differing impressions on those, that shall remember them: as the refulgent splendor of the sun obscures all the stars, and keeps our eyes from being any more affected by the greatest and brightest, than by any of the rest: so that our kindness to one another will be very little grounded upon external qualities, which will there either cease, or be eclipsed; nor upon secular relations, which will there affect us far less, than our being nearly related to our common Lord; our resemblance to whom will be the chief, as well as justest ground of our mutual esteem and

and affection. When children of the same parents have been early parted, and long bred in distant places, though, when they are grown men and women, they chance to meet again, it is observed, that at first they knew not one another any more than mere strangers; and when they are informed of their relation, it is not the little accidents, that happened to them at play, nor some features, that perhaps pleased one of them in the other's face, but are now very much changed by time and growth, that produce their new kindness; but the knowledge, that they are children of the same father, and their finding in each other personal qualities, fit to adorn their present state, and thereby to challenge kindness and esteem. And if some years absence can produce so great a change, as to make our nearest relations unknowable by us, and make us look with pity on the fondnesses, that trifles produced in us in our infancy; what changes, may we think, must be made on those, that conversed together upon earth, when after numerous ages, they shall meet in heaven, with minds as much changed and improved, as their bodies will then be? Shall we not, by the grounds of a virtuous complacency, be more affected and united, than we are now by natural relations, or by external beauty, and those other trifles, that here produce the greatest fondnesses?

BUT *Theodora*, (answers the surprized *Didymus*) can you be so rigid as to think, that pure and virtuous affections cannot be admitted into heaven? since the scripture informs us, that not only joy and desire are to be found even among the angels, (who are said to rejoice at a sinner's conversion, and desire to pry into the mysteries of our religion) but care and actings for opposite ends; (as when the angel of *Perſia* withstood *Michael*, and the angel, that talked to *Daniel*.)

I do not absolutely deny, *Theodora* replies, that the blessed know one another in heaven: and, says she, with a light change of colour, I am so far inclined to believe it is true, as, for *Didymus's* sake, to wish it so. But, as I lately told you, I am not apt to think, the sentiments occasioned by that knowledge will be such, as most men imagine. Besides those reasons, that you have ingeniously laid together, I think your persuasion of the saints mutual knowledge the more probable, because it seems not readily conceivable, how, at the great day of judgment, the justice of God, in rewarding and punishing particular virtues and crimes, can be manifested to the world, without discovering the persons, by whom they were performed; since personal circumstances do very much alter the nature of moral actions. And since the happy residents in heaven will have an eternity allowed them to converse with one another in, it seems highly probable, that in their various conferences they will meet with, at least some time or other, occasions, that by less sagacity than their enlightened minds will then be endowed with, may be improved to the discovery of the persons they were formerly acquainted with. But on the other side, (continues *Theodora*) we shall have such noble and charming entertainments to employ our attention, as will engross it from the little and despicable objects, (as we shall then think them) that now amuse or busy us; as when we behold such a pompous solemnity as a Roman triumph, the variety of splendid and magnificent objects, that successively present themselves to our view, make us so intent upon those surprizing spectacles, that even the nearest and dearest relations, though perhaps gazing at the same sight, out of the same windows, are apt to forget one another. And (continues she) even when the saints actually know and remember one another; they may love and converse, upon terms very differing from those, that were suitable to their mortal condition. Yes, *Didymus*, (adds she) as there will be no difference of ages and sexes, in heaven, as there are on earth; since all shall there be like the angels, and have bodies conformed to the glorious body of their Redeemer: so the rational friendships, that will be practised in that happy place,

place, will receive their measures from the new and personal excellencies of their friends; from their being rivals in the love of God; and from their differing degrees of resemblance to him, that is the *brightness of his glory, and the express image of his person*. But, concludes *Theodora*, we need not spend more time in discoursing conjecturally about questions, wherein the change we are now going to make, will soon bring us to be resolved. And, in the mean time, we may well rest satisfied with this assurance, that since heaven is a place, or state, where we shall be blessed with the *fulness of joy*; to know and converse with each other will be there found, either a part of our felicity, or not necessary to it.

C H A P. IX.

WHILST *Didymus* and his excellent mistress stood waiting, till the infamous ministers of the president's cruelty had prepared all things requisite to the execution of his barbarous sentence; among those many Roman soldiers, that were assembled there, to be spectators of the approaching tragedy, an officer, whom his own gallantry had strongly inclined to sympathize with a person, in whom he saw that quality so eminent, thought himself obliged to attempt the dissuading him from persisting in so fatal a resolution, as he had taken. Wherefore, approaching our martyr, with very obliging looks and gestures, and drawing him aside, The gods, says he, can bear me witness, generous youth, that it is not without some amazement, and more trouble, than any affliction of my own has been wont to give me, that I see the possessor of so much gallantry upon the point to be destroyed by an unhappy constancy, which, though in other cases a virtue, must, being exercised against the gods, become a crime. And therefore, I cannot but ardently wish, that after having shewn so much patience and courage, you would at length express your prudence too, by letting yourself be persuaded to a compliance, that may rescue you at once from impiety and from death.

AN advice, answers *Didymus*, that is proposed with so much kindness and civility, and yet pressed but by such unsatisfying reasons, does justly deserve my thanks for it, but not my compliance with it: for the argument you bring against my constancy to the truth, is only, that my persisting in it will cost me my life; which is a proof indeed, that the religion I profess, will lead me into danger, but none at all, that it has misled me into error.

It is altogether extrinsic and accidental to a religion's being true or false, that its embracers happen to be encouraged by preferments, or exposed to persecutions. Fear is but an ill counsellor in matters of religion, unless it be the fear of chusing a bad one, or living unworthy of a good one. He deserves not the blessing of having made a good choice among religions, that does more seek, in his choice, the concerns of his life, than of his soul. And as it is only for its being the true one, that we should make choice of our religion; so, having once chosen it, nothing should make us desert it, but a conviction of its being erroneous, and consequently of its wanting that truth, whose appearance made us embrace it. If therefore, you can shew me, that the Christian religion is false, or that yours is better; I am not so in love with wandering, as to go on in a wrong way, because I once have, by weakness or misfortune, been misled into it. But if your arguments be but menaces, or any thing, that is of that sort, which can only manifest, that the power is on your side, but do not at all evince, that the truth is not on mine; I must look upon what you urge, as not deserving to be complied with, but contemned. And if it were not my custom never to take any thing ill, that I think is meant well, I should esteem myself

myself not a little injured, by the argument you employ to make me abandon Christianity; since, if a person less civil and gallant had made use of it, I should conclude, that he must suppose me a coward, to hope by such persuasions to make a profelyte. And though I were less assured, than I am, of the truth of the religion I have always owned; yet would I not for all the world, on this occasion, by professing yours, desert it; lest by forsaking it, when I am threatened for sticking to it, I should procure myself a disquieting temptation to suspect, that I did not deal sincerely and impartially in chusing a religion, since I made choice of one, that I judged not worthy to be died for.

You mistake my intentions, generous *Didymus*, replies the Roman, if you think I pretended to fright you into apostacy: my virtue would as little allow me to have so unworthy a design, as your courage would permit a hope, that it should be successful. But looking upon myself, as having made a right choice in that worship of the gods, I make profession of, I could not think it injurious to you to persuade you, rather to live in the profession of a true religion, than to die for that of a false one. And since my concern for your safety, and the little time you have to deliberate, oblige me to speak freely to you; I cannot but wonder, that a person, that hath courted honour at the rate you have done, should lose himself, for one, whom the most sacred persons of his own nation crucified as a malefactor; and who has been so ill-natured, as to invite his followers, both by express words, and by the nature of the religion he framed, which could not but be persecuted, to involve themselves with him in the like unhappy fate.

THE notions (replies *Didymus*, somewhat nettled at this discourse) that idolaters frame to themselves, of the nature of the Christian religion, are commonly as erroneous, as the ways they take to confute it are improper, and inhuman; and they are usually no less misinformed about the grounds and mysteries of our religion, than they are mistaken about the objects of their own adorations. It is true, that the divine person I adore, being sent from God his father to be the great prophet and reformer of the world, did, with a prophetic freedom, as well as authority, sharply rebuke the superstitions of the Jewish scribes and pharisees, among whom he conversed; and did not more unmask their hypocrisy, and reproach their practices, by the light of his doctrine, than by the shining actions of a most exemplary and unblemished life. And his holiness having exasperated these impious hypocrites, that found their authority undermined, and their persons discredited by him; as their malice was too great, not to attempt the destruction of such an enemy, so his constancy was too great, to suffer him to decline the greatest dangers, by declining to persist in the wonted exercise of his virtues; whereby he thus became exposed to a death, which he foresaw, and frequently foretold, and which he also willingly underwent, to procure everlasting life for those, who should believe in him, and strive to imitate him.

AND that his death, whereunto he submitted to expiate the sins of others, was not inflicted on him for his own, was evident, by his being absolved, not only by the very judge, to whom a criminal fear of his accusers indicted the sentence he pronounced against him, but by that supreme and infallible judge, God himself; who declared by astonishing prodigies, both in heaven and earth, how much he was displeased with those, that put his son to death; and by raising him from the dead, within three days, to an immortal life, proclaimed, how dear he was to him, and gave him power to make his followers partakers of that glorious condition he himself was advanced to. So that (continues *Didymus*) those champions of his, whom he vouchsafes to single out from the rest of his followers, and call to martyrdom, have reason enough to look upon that call, as an invaluable honour, and a privilege: since,

as they are thereby made more conformable to him, in chearfully dying for truth and constancy; so they will be made more plentiful sharers in those inestimable advantages, that his own meritorious martyrdom procured him. Yes, for those, to whom he vouchsafes the power and honour of suffering for him, and of imitating him, for the interest of truth and piety, he does not only reserve such future recompences, to crown their love and fidelity, but often gives them here such happy foretastes, in a perfect assurance of it, that I cannot but look upon it, as a vast accession to that immense love, that made him die for us, that he calls and enables us to die for him.

I CONFESS, (*Didymus* adds in pursuit of his discourse) that, as he took upon him the form of a man, so he suffered himself to be used as good men too often are. But his miraculous power and goodness sufficiently proclaimed, that he was not thrown down from heaven to earth, as your *Vulcan* is said to have been; but that he descended from heaven, to make men live an heavenly life: nor did he, like many of your deities, especially your *Jupiter*, assume an human shape, to do actions below the dignity of human nature; but he taught men a doctrine, worthy, as well as likely, to be brought from heaven; and gave them an exemplary life, whose imitation would fit them to be translated thither; and then submitted to the torments and infamy of the cross, to purchase for his followers, by his death, that heavenly condition, for which he had qualified them by his spirit and his life.

THE Roman officer, not yet quite discouraged by the unsuccessfulness he had hitherto met with in his attempt, resolved to prosecute it yet farther, by saying, The same reason, that somewhat lessens my wonder at your despising death for your erroneous religion, increases my admiration at your unconcernedness to avoid the kind of death that threatens your obstinacy. For though the love of glory may invite a gallant man, like *Didymus*, to part with his life for the attainment of it; yet that same heroic passion ought to make those it possesses, more apprehensive, than others, of those extremities, wherein death is accompanied with infamy, and made justly terrible with ignominious circumstances; of which, none can be more disgraceful, than the receiving it at the base hand of a common executioner.

THE weakness and examples of your gods (replies *Didymus*) have too much seduced you, to make estimates of good and evil by those popular and pitiful measures, that I cannot but think very unworthy to be acquiesced in by a Christian; who, to merit that title, must be somewhat more than an ordinary man. We judge of good and evil actions by the laws of God and right reason, not by those of men in power; and therefore do not think, that constancy ceases to be a virtue, and consequently an honourable, not a disgraceful quality, because legal tyrants will call it obstinacy, and condemn men for it to the same punishments, that are allotted to dishonourable actions. The respect our religion commands us to pay to a civil magistrate, though a persecutor, permits us not by force to resist his unjust sentences. But this submission of ours does not at all keep his sentences from being unjust, nor forbid us to think them so; and consequently leaves us the inestimable satisfaction of our consciences, that inwardly absolve us, when outward judges condemn us. And for proof of this, you cannot but have taken notice, that, whereas truly criminal persons, being conscious of their own guilt, either deny what they are accused of, or endeavour by all means to palliate it, and to avoid the being condemned for it; we Christians, on the contrary, do not only confess, what you call a crime, but glory in it, and do not deprecate the fate, that attends our constancy. Nor can it fright us from undergoing death for a glorious cause, that we must receive it from an infamous hand. For that, by which we estimate it, is, the quality of the action, that procures it, not
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the condition of him, that is employed to inflict it: and so we can consider with joy for what, we are not much troubled to see by whom, it is that we suffer; being satisfied, that the executioner's hand may destroy a malefactor, but cannot make one; and if the cause, that brings the man to the scaffold, be not culpable, the place cannot make the death that is there suffered; infamous: nay, and if virtue leads him thither, the instruments of his death cannot keep it from being glorious; since this demonstrates the sufferer's unshaken constancy to be insuperable, not only by death, but by that, which many have embraced death to shun, the contempt of the generality of men. Your gallant Roman commander, *Attilius Regulus*, is much less remembered and celebrated for all his military exploits and attempts, than for the cruel death he suffered by order of the Carthaginians, to whom, in performance of a promise, he yielded himself up, with expectation of some such barbarous usage as he met with. And sure, as a submission to indignities was a duty not meanly glorious in him, to shun the breaking of his word to his enemies; the like resignation of themselves, will not, by unbiaſſed judges, be thought an action dishonourable in Christians, to prevent the violation of their faith solemnly given, not to a savage enemy, but to a divine friend, who has already, without any obligation to do it, suffered more shame for them, than the sublimity of his condition leaves it possible for them to suffer for him. And though that Greek philosopher, *Socrates*, whom your own oracles, with more of truth than they are wont to be guilty of, pronounced the wisest of men, was by his own fellow-citizens condemned to die by poison brought him by the hand of an executioner: yet since that sentence was not occasioned by his crimes, but his virtues, the deadly draught did not destroy his fame with his life; and poisoned not his reputation, which it extremely heightened, but that of his accusers, and his judges; whom after ages have looked upon, as worse criminals than ever they condemned, and more unworthy persons, than those they employed to execute their sentence. And for my part, (continues *Didymus*) some passages of our sacred records encourage me to expect, that, if a posthume fame be such a blessing as many imagine, the indignities we suffer now will hereafter procure it us. For I cannot but hope, and methinks I foresee, that the Roman eagles will one day stoop to the cross of Christ; and the temples of your false deities will be consecrated to the service of the true God. The sword of the civil magistrate, which is now the great and only successful argument on your side, will be then in Christian hands, which I wish may never employ it against your religion, whose ruin will not require the active opposition of power, but the bare withdrawing of its preserving support. And then posterity, more enlightened and more just, will read the history of those destroyers of the baptized (which is, at least, the innocenter) part of mankind, with the same resentments, with which they will read the havocks made by wars, plagues, massacres, and other public calamities.

C H A P. X.

THESE replies of *Didymus* made an end of convincing the person, that occasioned them, that our martyr's resolution was not to be shaken, either by threats or persuasions.

BUT yet the officious Roman cherishing some hope, that if *Didymus* should see his mistress ready to be killed by an infamous hand, that beauty, which had conquered his heart, would soften it, and thereby make it capable of relenting impressions; thought fit to make one address more, and tell him, It is not without extreme regret, that I see your inflexible obstinacy defeat all my endeavours to procure your safety.

But though your mistaken gallantry may make you think it unhandsome in a soldier, to disclaim a threatened opinion, that he once adhered to, lest the change should be imputed to fear or levity; yet I hope you will not think, that the strict rules of that destructive gallantry ought to oblige a young lady, in whose sex courage is, at least, an unrequired, if not an altogether improper, virtue: and therefore, I hope you will not refuse to second my endeavours to persuade her not to throw herself out of a world, of whose grandeurs and pleasures her transcendent beauty promises her an extraordinary share, as well as her youth fits her to relish them perfectly, and enjoy them long.

DIDYMUS, though at first somewhat surprized at this motion, took no long time to return answer, by saying; I confess I cannot partake of the trouble you are pleased to express, for the not prevailing of your endeavours to alter my resolutions; for though the advice you pressed upon me, was obliging in you to give, yet it would have been criminal for me to take it.

AND as for what you propose, in reference to *Theodora*, I must desire to be excused from making myself accessory to your design of tempting her: for, in my opinion, he, that solicits another to what he believeth a crime, doth become guilty of one; so that, as to what concerns *Theodora*, without being at all sure of shaking her virtue, I should most certainly ruin my own innocence. Yet I cannot think, (says the Roman, interrupting him,) but if you would enforce my persuasions with yours, the interest you have in her would prevail to make her rather accept of life, than deny a person, that she owes so much to, and does not less highly, than justly, value.

IF (replies *Didymus*) I should yield to use so criminal means, as to give her an example of the apostacy you would have me invite her to: the attempt would be less improbable: but for me to persuade her to what I am just going to give a convincing proof, that I believe to be worse than death, would make her both hate me and despise me. And to convince you, that such a motion as you would have me make, would lose me all the share I may have in her good opinion, I will dare to own to you, that if I thought her capable, I say not of endeavouring to seduce me, but of being seduced by me, my esteem of her would alter upon her change. And though I could not deny my wonder to so rare a master piece of nature, as is her visible part; yet there would be a vast difference betwixt a meer admiration of external beauty, which must become the trophy of age or death, and that high veneration, that I now pay to that admirable person's intrinsic worth and unconquerable virtue.

NOR should you doubt (continues *Didymus*) of the entertainment, that such a piety as hers would give such a motion as you would have me make; since it would justly give her a higher resentment of my solicitations, than of all the importunities of her heathen persecutors: for these do but advise her to decline danger, by embracing what they think truth; whereas that, which you would have me to persuade her to, is to purchase her safety, by renouncing, what I, as well as she, know to be truth: and I doubt not, that such a proceeding would so highly offend her, as to enable her, by a bare pardon, to acquit herself of those respects and services of mine, to which possibly a person of her goodness vouchsafes some title to her gratitude.

THERE is (replies the Roman) so great a difference betwixt the case of a resolved soldier, that thinks himself in point of reputation engaged not to retreat; and that of a young lady, from whom no resoluteness, much less obstinacy, can be expected, that I must yet think our joint persuasions, though unassisted by your example, would withhold her from death, now she is near enough to it to see the horrors of it.

NAY,

NAY, (rejoins *Didymus*) I did not speak what I have been saying about my own averſeneſs, that I might hinder you from trying your fortune, if you think fit, with *Theodora's* virtue. I do not envy her conſtancy (whoſe ſucceſſes have been hitherto no fewer than its trials) the honour of gaining more than one victory in one day. But what I have been ſaying, was to give you one reaſon of my reſuſing to join with you in your propoſed attempt; againſt which I ſhall now offer this other reaſon, that I think it little leſs than impoſſible it ſhould ſucceed. For I thought I had already ſatiſfied you, that as to my intereſt in *Theodora*, if it were much greater, than you, for want of knowing us both, imagine; ſo great a miſ-employment of it, would make me juſtly forfeit it; and perſuaſions, that would ſeduce her to apoſtacy, inſtead of making her follow the advice, would make her but deteſt the adviſer. And as to the hopes you ground on her ſeeing herſelf upon the point of paſſing out of the world; let me tell you, that the ſevere exerciſes, to which her ſtrict piety hath long accuſtomed her, have ſo diſingaged her affections from temporal things, that, being already mortified to the pleaſures and vanities of the world, death can now do no more, but free her from the troubles and perſecutions of it. She hath employed a great part of her life, in preparing herſelf to part with it joyfully, whenever nature and virtue ſhall require it; and ſhe will find it very eaſy to lay it down for religion, now ſhe is in a ſuffering condition, when in her moſt flouriſhing one ſhe found it enough to wean her from the love of the preſent life, that it detained her from the next. Great virtues, ſuch as her's, are like great rivers, which the nearer they come to the ſea, where they are to end their courſe, the greater they are wont to grow, and the more difficult the ſtream is to be withſtood or hindered from its progreſs. *Theodora* now looks upon herſelf, as having but one more ſtep to make, to reach that crown ſhe hath done and ſuffered ſo much for: and that glorious object viewed at ſo near a diſtance, ſo raviſhes and ſo poſſeſſes her eyes, that ſhe will doubtleſs either not ſee, or not regard, any thing, that would hinder or retard her taking poſſeſſion of it.

HERE the Roman officer, ſomewhat impatient at *Didymus's* diſcourſe, would no longer forbear interrupting it, by telling him; To hear you ſpeak, one would imagine that you are not talking of a young lady, but of ſome ancient hero, that had been long accuſtomed to deſpiſe the frowns of fortune and keep himſelf from over-valuing her ſmiles.

HEROIC virtue (replies *Didymus*) does as little know ſexes, as doth the ſoul, wherein it properly reſides. A habitude cannot always be eſſential to the nature of an heroic action; ſince the firſt of that kind, that one does, is not the conſequent, but the beginning, of a habitude; and a ſincere and ſettled reſolution to be highly virtuous may make a woman (as well as a man) to be that, which the nobleſt ſubſequent actions can but declare her to have been. And a perſon, that, like *Theodora*, acts by the aſſiſtance, and as in the preſence, of the Deity, may, to maintain her loyalty to God, and her title to the ineſtimable rewards he hath promiſed to perſevering piety, both act and ſuffer greater things, than thoſe very heroes you talk of were put upon, by ſuch barely human motives, as cuſtom, ambition, or revenge. And particularly, as to the point of perſeverance againſt menaces, and proſſers; theſe are not like to prevail againſt the conſtancy of Chriſtians much leſs poſſeſſed with divine love and hope, than *Theodora* is. And indeed, there can be nothing upon earth capable to bribe them, to let go the joys of heaven, that ſee themſelves entering upon the poſſeſſion, and find themſelves ſenſible of the ineſtimable value of them.

WHEREFORE

WHEREFORE (concludes *Dydimus*) you will not, I presume, think it strange, that I refuse to join with you in a design, that I could not so much as attempt, either with hope, or without a crime; and that thinking it worthier of my endeavours to imitate *Theodora's* constancy, than to seduce her from it, I chuse rather to be a sharer in the triumphs of her virtue, than a trophy.

C H A P. XI.

THIS resolute conclusion obliged the Roman officer to break off a conversation, whereby he plainly saw there was no cause to hope he could shake the constancy of *Dydimus*, and much cause to fear, that *Dydimus's* constancy and discourses would stagger many of the heathen auditors. And therefore withdrawing himself, much discontented at the unsuccessfulness of his persuasions, he thought it would be impious to make any intercession for persons he judged invincibly obstinate, or divert the fatal proceedings of the judge; who, having by this time made an end of those other affairs, whose dispatch *Theodora's* respite was not to outlast, called for the innocent criminals, and, with a stern countenance and voice, demanded, whether they were yet willing to appease the deities they had provoked; and, by burning incense to them, endeavour to atone for the affronts they had offered them; adding, that there was now no more time left for deliberating, but that they must immediately renounce their impious religion, or suffer death for it.

BUT this could not shake the illustrious prisoners constancy, which prompted them to make, with as much haste as the president could desire, an answer, that consisted but of a short and resolute declaration; that they had lived worshippers of Christ, and had a thousand times rather die, than cease to be, or to profess themselves such; and that for the false Gods, the president would have them adore, they had rather be their victims, than their suppliants, and fall sacrifices to them, than offer them any.

THIS bold profession so incensed the person it was made to, that he immediately gave order, that the prisoners should be led away to the place of execution; and that the ministers of justice, (as he misnamed his cruelty) should, without delay, go on with the preparations, that were making to destroy them. But while these officers were solicitous to obey those commands, *Theodora* took the opportunity, to tell the generous companion of her sufferings: It was fit, I confess, when we discoursed with infidels, to recommend the objects of our hopes, by giving them the glorious titles of crowns and triumphs; since being to defend the reasonableness of our constancy, by the greatness of the rewards we expect for it, it was very proper to represent those celestial recompences, under the notion of such goods, as those we argued with acknowledged to be the most noble and desirable. But, (continues she) when we speak of Heaven among ourselves, give me leave to tell you, that I think we should look upon it under a very differing notion; and make a wide disparity betwixt the Christian's paradise, and the poet's elysium. The triumphs we should most desire in Heaven, should be, not over our outward enemies, or personal sufferings; but over sin and ignorance, and the frailties of our natures, and the imperfections of our virtues. And the positive blessings, that should most endear Heaven to us, should be, not so much, that we shall there be crowned by Christ, as that we shall live with him, and follow that spotless lamb, where-ever he goes; that our gratitude itself shall be perfect, as well as the blessings, that engage it, shall be compleat; and that we shall have an eternal day to contemplate that sun of righteousness, without having that glorious object veiled by any interposing cloud, much less hid from us by

by the vicissitudes of day and night. In short, I think, devotion should in our future state aspire to other things, than those, that may be the objects of meer ambition.

AND now, generous *Didymus*, (adds *Theodora*) since we are entering upon the last scene of our mortal life; let us (I beseech you) summon together and rouse up all the graces and virtues we have received from heaven, and fervently implore both an encrease of them; and a supply of any, that our present circumstances require; that we may go off the stage piously, as well as handsomely, and both act and suffer as becomes Christian martyrs. Let not any cruelties or affronts of our insulting persecutors be able to discompose us; but let our evenness of mind convince them, that they can as little disorder us in our way to heaven, as hinder us to get to our journey's end. But let not our undauntedness appear the effect of fullness, or fierceness, or of meer resolvedness; but let it be so calm and charitable, that we may not be suspected to be the martyrs, rather of our glory, or our courage, than of our religion. Let it not be thought, that we hate life, or despise it; but only that we think it a cheap purchase for heaven, and for the honour of owning and following a redeemer, who, to merit it for us, took the cross in his way thither.

ADMONITIONS so becoming a dying Christian received such an entertainment, as the piety of it, and the veneration he had for the giver, might justly challenge from so devout and elevated a soul, as that of *Didymus*; whose resolute answers to the Roman officer, together with his behaviour, as well since as before he made them, leaving his enemies no more expectation, that he could be prevailed with, either to alter his own resolution, or tempt his mistress to change hers; he was appointed to be first led away to execution, that the sight of his blood might terrify *Theodora*, and fright her into a care to preserve her own. This resolution of his enemies did not at all lessen his; but having easily obtained leave from the Roman officers, that could not but admire his gallantry, and somewhat compassionate his condition, to say a few words to *Theodora*, he went to that excellent person; and approaching her with a far greater respect, than he would shew to any power, that could but preserve that life, which the Romans were going to take from him, he told her: Your piety, madam, and your example making me presume, that, upon such an occasion as this, I may, with your consent, part with a life, which, ever since I had the fate to see you, has been so much at your disposal; I am now going without reluctance to perform that last duty, whereto religion calls me. But thinking myself obliged to begin with the most difficult part of my martyrdom, before I bid farewell to the world, my inclination and respect brings me to take my last leave of the fairest and excellentest person in it. If, madam, (so he proceeds) I were in a condition of paying you any further duties, my humble request to you would be, to have the honour of your further commands. But since my condition leaves me not a capacity of serving you for the future, one of my last petitions to you must be, to be pleased to look upon my past services, as extremely short of the desires of a person, that loved you with as much ardency, as your charms themselves could kindle; and yet with so pure a flame, that had it been visible, even *Theodora's* virtue could not have disapproved it. But madam, (continues he) although to rescue you from the condition you are in, there is no danger so desperate, that I would not joyfully attempt, if I were again at liberty, and though it were possible I could survive you; yet I am too much concerned for the nobler part of *Theodora*, to wish she would blemish so spotless a life to save it. Only, madam, give me leave to be so kind and charitable to the world, as to wish, that providence may find some expedient to preserve for you both your crown

crown and your head; and that you may arrive so late at heaven, as to have time to bless the earth with a long and exemplary life; and may you lead it with as much tranquility, as you will with virtue; and without knowing so much as that trouble, which, I fear, your generous compassion may now and then offer to give you upon the remembrance of the faithfullest of your servants.

THESE words, and the sad occasion of them, having drawn some tears into *Theodora's* fair eyes; though the cause of them made them very obliging to *Didymus*, yet his concern for her quiet presently engaged him to help her to suppress them, by making haste to tell her, that it was pity the serenity of her mind and looks, which virtue had still kept calm, and even persecutions had not been able to disorder, should be discomposed by any other thing. And madam, (continues he) though being confident, that your charity will make it unnecessary for me to beg your prayers, I was going to make it my petition to you, that you would vouchsafe now and then to cast a thought on the memory of a person, to whose mind you were constantly present; yet I must now retract that humble request, unless you are pleased to grant it me with this qualification; that the honour you do me, may not be disquieting to you. For how great a blessing soever it is, to enjoy a place in your thoughts; yet an idea must represent quite another man than *Didymus*, that should, especially on its own score, become troublesome to *Theodora*, whose compassion is as well needless, as undesired; since it is injurious both to herself and me, to look upon him as a person to be pitied, that is going to receive the honour and satisfaction to suffer in her sight, what he suffers partly for her service. And the place he implores but in her favourable, not her mournful thoughts, will give him the noblest and desirablest being, that he can have upon earth, when he shall be in heaven.

THE things, which *Didymus* said, and the pathetic way he said them in, did not leave the fair person, they were addressed to, all the unmovedness of mind she used to be mistress of on other occasions. And considering these as the last and dying words of an accomplished gentleman, that had so highly served and loved her, she could not hinder her resentments from making her, on such an occasion, remit somewhat of her wonted reservedness. Wherefore with eyes, wherein though she endeavoured to suppress tears, she disclosed an extraordinary grief; and with looks, wherein both gratitude and obligedness displayed themselves, she told him, If I looked upon your virtue, generous *Didymus*, as one, that were but somewhat extraordinary, I should think myself obliged to make excuses, and seek your pardon for having been, though undesignedly, so accessory to the early loss of a life so worthy to be a long one: but what you have this day done, makes me apprehend, that such discourses would not be very pleasing to one, that delights in such actions. But do not think, I conjure you, that though I cannot pretend to merit or requite services of so unusual a strain as yours, I can be insensible, how much I owe to them, not only upon the score of their greatness, but upon that of the handsome and generous way, wherein you did them. For (continues she, with a colour, that somewhat expounded the meaning of what she was going to say) if after the virtue and gallantry you this day expressed, providence had thought fit to place me in a condition of making you retributions, I will allow you to think, that, in chusing them for you, I should have been very much if not unreservedly, guided by your wishes. Here she paused a while, and blushed; the latter, that she had said, what to her niceness seemed so much; and the former, to consider, whether he deserved not to have more said to him. But her obliging looks did so well

second and expound her otherwise somewhat indefinite words, that *Didymus's* heart readily understood the language of her eyes; and her heart spoke so clearly in her cheeks somewhat, that it scrupled to utter by her tongue, that, expressing more than she said, without injuring her modesty she righted her gratitude; her passionate admirer esteeming himself more highly recompenced by this permission to suppose her kindness, than he would have done by the perfectest assurance of any other's love; and, fancying, that by the sight of that new fire, that flashed in her cheeks, he could discern in her breast such a resentment of his services, as involved an approbation of their cause, and implied a peculiarity for his person; he took the highest retribution he ever did, for the highest he ever could receive from a lady, whose beauty and reservedness were so great, that no favour of her granting could appear little.

BUT *Theodora* quickly recovering the disorder this merited declaration had put her into, made haste to prosecute her discourse, by adding, but it is my satisfaction, and will, I hope, be yours, that since you acted upon religion's score, as well as mine, you will not want a recompence, greater than it had been possible for me to give you; since in rescuing me upon a Christian account, you have served a master, that is able most richly to reward, even your performances and sufferings. And doubt not *Didymus*, (continues she) but that, when you shall once be possessed of a glorious and immortal crown in heaven, you will have no cause to be troubled at your having, upon earth, lost a crown of laurel, or missed one of myrtle. If I were to tarry, or rather languish, here below, as many years as your mistaken kindness makes you wish me; your favours have been so extraordinary, that, without being guilty of an ingratitude, that would be so too, I could never lose the remembrance of them, nor omit paying you the highest acknowledgements, that the chief place, not only in my memory, but in my esteem and friendship, could make you. But do not, *Didymus*, I beseech you, think of my surviving you, when the holding out a few minutes longer for Christ will introduce me into a condition, where I shall ever see him, and never offend him. Let us then (concludes she) quit the thoughts of this world, that we are going so soon to quit, and begin to fix them on those joys of another, that we are going to possess for ever; and during that little time, that is requisite to go take our crowns, let us summon up all our powers, to contribute to a behaviour befitting such expectations. Let our last services to religion be our noblest ones, that our deaths may at least adorn it, if not propagate it. Let us receive the last effects of our persecution, as persons, that do not deserve such an usage, and are above the reach of it. Let us aspire to Christ's temper in his cause; and suffer like him, as we suffer for him: and then we need not doubt, but in spite of this short separation we are yielding to for his sake, we shall joyfully, and for ever, meet again in a better place, and in an inestimably happier condition.

Theodora had scarce made an end of speaking, when all things being in a readiness to put the judge's sentence in execution, they, to whom that infamous employment was committed, came to bring notice of it to *Didymus*; who, notwithstanding the reluctancy he had to part with the admirable, and now obliging, *Theodora*, thinking it would misbecome him to stay for being pressed on such an occasion, delayed not, with all the resolution he was able to assume, to take his last farewell of her. This cruel separation being not to have an end before both their lives, was solemnized by that excellent pair with gestures and expressions so sensible and moving, that declining an account, which I could not attempt to give, without sharing very much in a

grief, that I should be able, but very imperfectly, to describe; I shall silently pass over the circumstances of this sad separation, that more troubled the generous lover, and perhaps his admirable mistress too, than that of soul and body, which was presently to follow it. But *Didymus*, now finally parted from *Theodora*, whilst he was moving towards the place of his sufferings, did, by the assistance of him, whose religion called him to them, assume a temper of mind suitable to the glorious work he was going to undertake, and entirely disposed himself, after having done all, that became a lover, to suffer as became a Christian.

THIS was much the less difficult for him to do, because his whole past life was an excellent preparative to make him act the last scene of it worthily. For (to add somewhat on this occasion, to the character given of him in the first book,) *Didymus* was a person, in whom divine grace had produced so early a piety, that he was a well grown Christian, before he was come to be a full grown man. And judging the most flourishing time of his age to be, for that reason, the fittest to be devoted to the most worthy of objects; he was enabled both to suppress the heats of youth, and despise the vanities of the world, even while that usually ungoverned age made the former most impetuous, and gave the latter the great endearment of novelty. Nor did his being a soldier prove an obstacle to his piety. The examples of *Joshua*, *David*, *Jonathán*, and other brave warriors of the old testament, shew, that heroic valour may be accompanied with eminent piety. And the first proselyte the heathen world presented to Christianity, being a captain, and continuing to be so after his conversion, argues, that a military state of life is not inconsistent with the most innocent of religions. And for *Didymus*, as he fought not out of fierceness, or avarice, or ambition, but to exercise and improve his virtue; so amidst all his military conflicts he was still careful *to fight the good fight of faith*: and being taught by the holy scripture, that *the life of man here on earth is a kind of military one*, he used the Roman camp as a school to a higher sort of warfare; where, as the hardships are greater, and the victories more difficult, so the crowns and triumphs are incomparably more valuable and glorious. A person thus qualified and disposed could not find it very uneasy to part, for his religion, with a life, that he had led so well, and hazarded so often; nor to leave a world, that sin and persecutions embittered, and that was presently to be left by *Theodora*, that he might pass to a place, where they should meet to be crowned. Wherefore, resolving to shew, that the approach of a reputedly infamous death was not able, either to shake his constancy, or extinguish his charity; he disposed himself to mingle in his last actions and sufferings the courage of a Roman soldier, with the resignation of a Christian martyr. And accordingly, walking on towards the place of execution with a calmness and undauntedness, that could scarce have proceeded from a resolution not strengthened by faith; as soon as he came thither, he looked round about him upon the guards, and other assistants of this sad spectacle, in such a way, as if he rather pitied them, than liked the pity, which many of them could not but by their tears express for him, and discoursed to them with all the gracefulness, that youth and courage could give so extraordinary a person. And because he supposed, that (as it was usual on such occasions of concourse) there were among the spectators some military men, that were Christians in their hearts, though they had not been called to own it publicly; he addressed himself particularly to them. And having premised, that he pretended not to instruct them as barely Christians, because he doubted not, but he had been prevented by the weighty and moving sermons of divers burning and shining lights, and guiders of the church; he told them he would confine his advices to what was
suitable

suited to the condition he shared in with them, of being Christian soldiers. And then he briefly, but pathetically, exhorted them to all those virtues and practices, that might recommend both their persons, their profession, and their religion: the last of which, by many arguments, (which his example made the more impressive) he persuaded them, after having adorned it by their lives, to confirm, if they were called to it, by their deaths; without forgetting, that the fearful are by the scripture ranked with the *unbelievers*, as destined to the same place of torment; and without fearing any unmerited disgrace, so much as that deserved one, threatened by the captain of their salvation to those, that *shall deny him before men*. He exhorted them, by their courage and obsequiousness to convince their unbelieving superiors, that the valour of Christians could be eminently active, when their religion did not confine it to be passive; and that when enterprizes, how dangerous soever, were as just and noble as difficult, they could emulate, if not outshine, the gallantry of those deified heroes they refused to worship. And lastly, having pressed them to be loyal to the Emperor, and obedient too, as far as was consistent with fidelity to him, that made him so; he begged their prayers for himself, and put up ardent ones of his own, for the church, the state, his persecutors, and, particularly, for the excellent companion of his martyrdom. This said, he began to do what was to be done by him, towards the deliverance of his soul from his body; and having done it with so much serenity of mind and looks, that he extorted an esteem of his virtue, even from those, that destroyed him for it; he let the executioner do his part too, (which probably was done by taking off his head) and in a moment passed from being a suffering member of the church militant, to be a happy one of the church triumphant.

Rev. xxi.

8.

Heb. xi.

10.

C H A P. XII.

THE persecutors of *Theodora* hoping to intimidate her by so tragic a spectacle, had conducted her to a place, whence she might see all, that had passed; of which it will easily be believed, that she had not been an unconcerned spectator: her virtue and kindness making her a sharer in his sufferings, by sympathizing with him, and by endeavouring, as far as she could, to relieve him by her most ardent prayers; that his constancy under them might be divinely supported, and richly crowned. But while her thoughts were, with a divine grief, solemnizing her loss, those cruel men, that had procured it, being desirous to make use of the terrifying impressions they supposed she had received, while they were fresh and recent, advanced to *Theodora*, bringing with them the purposely disfigured remains of *Didymus*; and then told her, that she was now convinced, that neither youth nor gallantry was able to protect from the fatal anger of the Gods those, that obstinately refused to worship them; and therefore they expected, that, by a seasonable care of herself, she would shun the imitation of so tragical an example. To this the fair martyr replied, that she was not at all surprized at what had passed, and therefore she knew not, why she should be terrified by it. For *Didymus* and she, and all other considering Christians, that walk according to their master's directions, were wont deliberately to weigh the consequences of embracing a strict and persecuted religion, before they made profession of it: and having foreseen what it might cost them, and satisfied themselves, that it deserved a yet higher price, they were not discouraged nor surprized to be put to pay that price; especially when it opened to them an immediate passage to the possession of what they gave it for. She added, that if the example

of the generous martyr were to have any operation upon her, it ought not to fright her from, but confirm her in, the profession of a religion, whose truth he thought worth dying for; and which, notwithstanding all the handsome concerns he had for her preservation, he would never speak one word to persuade her to decline, for the protracting of her life. His example (continues *Theodora*) lets me see, that no violences upon earth are able to destroy a courage, that is assisted from heaven, and fights in view of the glories of it; and his death manifests, how quick the passage may be between this and an incomparably better life; and clearly shews, how soon the utmost effect of your cruelty can place those, that despise it, above the reach of it. Then casting her mournful eyes upon the saddest object, that ever they beheld; If you should, says she, be so inhuman, as to exercise any further cruelty upon this now inanimate prison, whence his glad soul has escaped, you may intend him a mischief, but he will not feel it, unless it be in the increase of the recompences of his martyrdom. You may, if you please, insult over his dead body, and those, whom his virtue made his friends, may some of them be troubled at it; but while you are triumphing at his death, and others are deploring it, I doubt not, but the welcomes and joys he receives in the blessed place he is gone to, make him happy enough to pity not only those, that hate him, but those, that pity him too. What you shew me, as the trophy of your power, I look upon, as that of his constancy; and for what you presume to be your victory, he will be really crowned. The grave, (continues she) is, I confess, a sad prospect to them, that look no further, and terminate their sight there; but not to those sufferers for the truth, who, with the eye of faith, looking beyond it, see all those glories on the other side of it, that expect them there; whereunto as some kind of death must necessarily be the way, so martyrdom of all others is the noblest. Wherefore, (concludes *Theodora*) you will very much miss your aim, if you forbear bringing my constancy to the last trial, only upon hopes, that death dressed with unusual horror, by being besmeared with *Didymus's* blood, should frighten me into apostacy; for I am much less terrified by his fate, than encouraged by his example: in imitation of which I declare to you once for all, that, as I always valued this world too little, to be much afraid to part with it for a better; so I shall never be brought to quit an excellent religion for a bad one, for fear of exchanging a wretched life for a happy one.

THIS positive and final declaration of *Theodora* did so enrage those, to whom she made it, that finding themselves quite disappointed of the hopes they had to terrify her by their last expedient, *Didymus's* death, they presently led her away to participate of his fate, which they found her resolved not to decline. And now the admirable *Theodora*, having received that cruel, but welcome command, most readily disposed herself to obey it: and considering, how near she was to put a period to all the afflictions of her life, by the gloriouslest action it could be concluded with, and how soon she should enjoy the happiness of entering heaven, thorough the straightest and noblest gate, at which it is accessible; her beauty, that was before admirable, appeared more so than ever, being strangely increased by the effusions of a celestial joy, that did too much abound in her heart, not to flash out manifestly in her looks, to whose native charms it superadded so much lustre and majesty, that she seemed (upon some peculiar design) to be newly come from the heaven she was going to. So great a constancy and cheerfulness of mind, upon so sad an occasion, wanted not a resembling operation upon the generality of the wondering assistants: for though the report, that was quickly spread of so uncommon an action, as that of *Theodora*, done by so an extraordinary a person, as fame had represented her to be, had

had drawn a great concourse of people, to see one, that acted, as well as looked so handsomly; yet when they had a while beheld her, and saw the cruel instruments of what she was doomed to suffer; among that numerous throng of spectators there were none, that were not admirers; many, that looked on her with dazled, and few without flowing eyes; every sort of spectators found something in her person and condition, that made them mournful ones. The Christians that chanced to mingle with the rest of the crowd, lamented to see their religion deprived of so great an ornament, and so shining an example; though their grief were moderated by considering, that she was entering into a most happy place, to which they might hope, ere long, to follow her. And, in the mean time, it was no small credit to their religion, that a lady of her beauty had lived according to the strictest laws of it; and a person of her youth and sex was ambitious to die for it. Those among the spectators, that yet retained Roman spirits, and were the genuine offspring of those noble ancestors, that scrupled not in *Rome* itself, to allow public marks of honour to its greatest enemies, could not but be troubled, to see so rare a thing as a female hero-punished for a generosity, that could not sufficiently be rewarded, and brought to an untimely, and, in popular estimation, ignominious end, for having followed dictates of gratitude and piety. Those infidels, on whose sentiments virtue had more influence than superstition, were very much dissatisfied with the rigour of their magistrates; thought it a discredit to their religion, to use such barbarous, and yet ineffectual courses, to fright men into it; and they thought it an invidious service to their gods, to destroy the fairest master-pieces they had made. But those, that seemed most to deplore the fair martyr's condition, were those, that were disposed to have their affections wrought on by their eyes, and were apt to be influenced by beauty: for these much repined and grieved to see so glorious a sun reduced to set in her east; they envied *Didymus*, for having so generously served and suffered for so rare a person, who, they thought, instead of the barbarous usage she received, deserved to be as happy, as her smiles could make her adorers; and they allowed themselves to think, that nothing could be a virtue, that deprived the world of so much beauty. In short, most of the by-standers grieved, to behold a person, whose youth would pass for innocency, and whose charms would give her captives among savages, destroyed in *Greece*, by Romans. So that bating those few barbarians, whose superstition and malice brought her to that condition, all the other spectators of her sufferings were deplorers of them too; and many to that degree, that, to judge by their looks, and those of our fair martyr, one would have believed, that the assistants were to be sufferers in the approaching tragedy, and she but the spectator of it.

AND now the matchless *Theodora* came to the place, where her aspiring soul was to take its flight to heaven. In order to which, she first looked about her, with a kind of pity, on those, that either never, or later than she, were to be admitted into the felicity she was presently to possess: and afterwards she paused a while, to recover from some disorder, that she was put into; not so much to see herself invironed with guards, as surrounded with gazers. And then, though her bashfulness made it more uneasy to her to speak to the assistants, because her speech must be a public one, than because it must be her last; yet with a voice and gestures, wherein the modesty of a virgin, and the courage of a martyr, were happily tempered, she addressed herself to those, that were about her, in such as the following terms:

SINCE

SINCE custom has made it a kind of duty, that those, that come to this place, should say something to the spectators, and make a public confession of their guilt, or protestation of their innocence; I shall, in part, do both the one and the other; for I will not deny, that I am, what the laws have condemned me for being. Yes, I own myself a Christian, and in spite of all my past and approaching sufferings, I declare, that I think it an honour and a happiness to be so: but, on the other side, I can most truly protest, that I have transgressed no other Roman laws, than those, that are repugnant to those of God and reason. And since we Christians are taught by our great Master's example, as well as precepts, not only to forgive, but to love our enemies, and pray for our persecutors; I think myself obliged, and, by his assistance, find myself enabled, not only to forgive, as I heartily do, the procurers of my death, but ardently to implore for them the blessing, and the unmolested exercise of a religion, that they see I value more than I do my life. And I hope, those in authority will, by the frequent executions, that daily succeed one another in this place, be at length convinced, how ineffectual, as well as inhuman, a way they take to extirpate Christianity; which being an heavenly light, can be as little ruined by the violence employed against it on earth, as tempests can extinguish the sun. And because it is likely, that charity or curiosity has, among other spectators, brought hither some Christians, I shall now address myself to them; yet not to desire their pity, but their prayers, that I may be enabled to overcome the last enemy, death, and finish my course in such a way, as may neither blemish my past life, nor the glorious cause I gladly lose it for. But the chief part of my request regards yourselves, not me: for I must beg you to remember, that, besides an All-seeing-eye, there are many eyes upon you, that pry into your actions with strong desires to find them criminal; and that though the truth, nor the subsistence of Christianity does not, yet the credit of it does much depend upon the nature of your actions. For as all your personal faults will be imputed to your religion; so your shining virtues will probably bring many infidels, first to admire, and then to embrace Christianity; justly concluding that that religion must be excellent, that makes its professors so, and enables, as well as enjoins them, to live blameless in the world, and go joyfully out of it. If you lead such lives, you will not be much afraid of martyrdom, which will but send you sooner to receive those inestimable rewards of them, that God's goodness hath promised and provided. I wish you may never have cause, nor, upon occasion, want courage, to enter into life at that straight gate, that I am now going to pass through. But if you be called to that way of glorifying God, let neither the ignominy, nor the painfulness of it deter you. It is not shameful, but glorious, to suffer for God, for truth, and for a crown; and my example may encourage the weakest of you to expect, that *God's strength will be made manifest in your infirmity*; and that there is no temptation but may be resisted and vanquished by the weakest hand, that is supported and strengthened by an almighty arm. And though the distance between heaven and earth, our mortal and immortal state, be very great, yet the passage between them may be very short; and a few moments may bring us to exchange our agonies for extasies, and pass from the lamentations of our friends, and the reproaches of our persecutors, to the congratulations of angels, and the solemn welcomes of him, whom even those heavenly spirits adore.

As soon as she had ended this discourse, though her soul, abandoning such a body as her's, could scarce any where, but in heaven, find an advantage by a change of mansion, yet it cheerfully disposed itself to a separation, that would give it a closer

and

and more immediate union with the divine object of its cœlestial love. And after she had decently and calmly made all the preparation, that on her part was requisite for what she was to suffer, she thought fit to make her life's last actions, as most of the rest had been, acts of piety and charity. And therefore elevating her eyes and hands towards heaven, where her heart, as well as her treasure, had been placed long before, she first paid her God most humble thanks, for the grace and opportunity he had vouchsafed her, *not only to believe in his divine Son, but to suffer for him*; and then made a short, but very fervent prayer, for the church, for her enemies, and for herself. Which done, with a countenance, wherein serenity was mingled with joy, she gave a sign to the executioner to do his office, who thereupon did all that was necessary to complete her martyrdom. And the glad soul was by ¹ Cor. xi. the angels, (whom she had aspired to resemble in purity and devotion) carried to ⁹ that happy place, whose glories are neither to be conceived by those, that have not ² Cor. xii. seen them, nor described by those, that have; such supernatural felicities as much ⁴ transcending man's ideas and his expressions, as they surpass his merit.

MEDICINAL

MEDICINAL EXPERIMENTS:

OR, A

COLLECTION

Of CHOICE and SAFE

REMEDIES,

For the most Part SIMPLE, and easily Prepared :

Very useful in FAMILIES, and fitted for the Service of COUNTRY PEOPLE.

The PREFACE to his RECEIPTS sent to a FRIEND in *America*, in the Edition printed at *London* in 1688, and omitted in the subsequent ones.

The INTRODUCTION.

THE following prescriptions being but part of a collection of receipts and processes, that had from time to time been recommended to me, either by the experience of the imparters, or by my own; I did not think it so expedient to promise, to so small a number of slight receipts, the several medicinal cautions and other considerations, wherewith it might be fit to usher in a larger writing of this nature, as to reserve those prolegomena for the whole collection, whereof that, which now appears, makes but a part, and that not the greatest. Which intimation will, I hope, excuse my leaving unmentioned the names of the imparters of several of these receipts; since all of them are transcribed from the collection; and the reason of the omission is given in the preamble, together with divers advertisements about the work itself, which dispense me from giving any others at present, than those very few, which seemed requisite to be sent about the following paper, to the inquisitive D. W. A. practising physic in *New England*; who earnestly desired of me some receipts, that, being parable or cheap, might easily be made serviceable, especially to the poor, in that country; where European books of physic are too great rarities, and several remedies, here known, are not in use.

THE beginning of my letter to Dr. A. consisting mainly of things, that regarded his peculiar circumstances, it is needless, if not improper, to transcribe it hither, and consequently it ought not to keep me from proceeding, without delay, to the next part of my letter, which gives him the three following

ADVERTISEMENT S.

I. It would be a great mistake of my design, in sending you the following receipts, if you should think, that I at all pretend them to be infallible ones, or at least

least of very extraordinary efficacy; since all, that I told you of them, was, that, for medicines so simple, and for the most part so cheap, I have found several of them, and take all of them, to be good in their kind. And though I think most of them safer than many other medicines, that are in great request, yet I do not pretend, that these should play the part both of medicines and physicians too; but only that they may be usefully employed by one, that, like you, knows how to administer them discreetly. In short, I say not, that these medicines are the best I have, but only some of the most parable, or simple; both which I here mention together, as if the latter were referrible to the former; not only because medicines, that are simple, or but very little compounded, are, *cæteris paribus*, more easy to be procured, but because I am willing, that this short collection should furnish you with divers instances to confirm the paper, to which I desire you would subjoin it, of the usefulness of simple medicines.

II. IT may somewhat assist you to make a comparative estimate of the following receipts, if I distinguish them into three classes or orders, and annex to the title, or description, of almost each particular medicine, one of the three first letters of the alphabet. Whereof *A* signifies, that the remedy it belongs to hath been, either by the affirmation of the physician, or other credible persons, that imparted it to me, or by trials, that I caused to be made of it, recommended as very considerable and efficacious in its kind. *A* therefore is the mark of a remedy of the highest class of these. *B* denotes, that that, which it refers to, is of a second or inferior sort, but yet considerable for its good operations. And the letter *C* belongs to those remedies, that are of the lowest order, though good enough not to be despised.

AND because I presume it may be expected, that I should give you some short character, of those, whereof I have had some kind of experience, whether by the relation of such as have been cured or much relieved by them, or by my own exhibiting or prescribing them; or by reports received from those, that engaged to try them, or that employed them upon my account: for this reason, I say, and for brevity's sake, and avoiding repetitions, I thought fit to accompany almost each of the three forementioned alphabetical letters, that refers to a receipt, of which I can say any thing upon some kind of knowledge of my own, with one of the three following marks: whereof the first, which is the small figure of (1) denotes, that I have known but a single trial of it; the other, which is a simple cross (+) imports, that the trials have been made two, or some few more times; and the third, which is an asterisk (consisting of several lines crossing each other in one point) (*) signifies, that the trials, wherein it hath been found useful, were many, if not very many.

III. THERE will be easily observed a disparity of style in the following papers; for those receipts, that were my own, were expressed in my own terms; and so usually were those, that I received from others but by word of mouth; and these, I hope, will be found clearly enough delivered: but as to those others, that were imparted to me by empiricks, or unlearned persons, in writing; though I would not, in divers places, have worded them as they did, that I had them from, yet I oftentimes made a scruple to correct or alter their expressions, though not suitable to the current style of the formularies of receipts; being more concerned, that the meanings should be close kept to, than the style rectified. And sometimes too, when I received things by word of mouth, and committed them to paper in the author's presence, haste obliged me to make use of expressions, (and made me afterwards forget to mend them) that were rather the shortest than the best; and sometimes forced me to employ

ploy words of the Latin, French, or some other language, especially if I wrote after the instructions of foreigners: being less careful to express things in the fittest way I could, than in the most compendious.

You will receive, by this ship, but five decades of receipts of parable medicines, because I think that number sufficient to be sent at once. But if, when you have tried them, the success, that God shall vouchsafe to give them, shall invite you to press for a recruit, I shall thereby be encouraged to draw some other decades of receipts (some of which will perhaps be preferable to most of these) out of a collection, wherein they have long lain mingled with receipts and processes of remedies of a less simple nature, or more difficult to be procured.

The PUBLISHER to the READER.

THESE receipts, taken out of a large collection, as consisting of a few safe ingredients, commonly to be found at easy rates in most places, were sent to a learned physician beyond sea; to whom they were a welcome present, and answered, without doubt, the ends he had in desiring them.

THAT excellent person, to whom these choice prescriptions are owing, did permit a few copies of them to be printed, and was pleased to put them in the hands of some of his friends, provided, as there was occasion, they would make trial of them, and faithfully report the success.

DIVERS of those, who, on these conditions, had received so great a favour, held themselves obliged to inquire for persons affected with any of the maladies against which the said medicines were prescribed; and, upon many experiments carefully made, having found, that frequently they have relieved those, who used them, and sometimes strangely outdone expectation; they addressed themselves with much importunity to the noble author, to suffer things, which were of such general benefit, and so easily to be procured by the poor, to be made more public.

AND at length he hath been prevailed with, not only to allow the former receipts, which but few had seen, to be reprinted; but hath, out of his rich treasury, stored us with a fresh collection, which, as in number it exceeds what we had before, so in quality and virtue it falls not short of it.

AND if what here with such an honest and kind design is offered to the public, be but candidly and favourably received, we may still hope for more blessings of this sort from him, who has not only a constant will and great abilities to do good, but hath, perhaps, obliged the age as much as any private person in it.

The AUTHOR'S PREFACE.

THOUGH physic be not my profession, yet I hope this small collection of receipts will not incur the censure of equitable and charitable persons, though divers of them are professed physicians; since, as I was induced to what I had done by the dictates of Philanthropy and Christianity, so I was warranted by great examples, both in antient times and in ours. Of the former sort, I take notice of several of the old philosophers, such as *Democritus*, *Pythagoras*, to which some add *Aristotle*; and even divers monarchs and great men of those times, such as *Jubat* king of *Mauritania*; another king, *Nechepsos*, cited by *Galen**, *Pliny*, &c. And of the second sort,

* *De simpl. medic. facultatibus*, lib. ix. titulus *Jaspis Viridis*. *Ac nonnulli quoque annulis inferunt, scalpuntque in eo draconem radios habentem: rebus rex Nechepsos memorie prodidit in sexto et decimo libro.*

not only by the last age, and the first part of our own, but by very late times, and in a neighbouring nation, whose customs we are wont sufficiently to esteem and imitate, we may be furnished with examples to our present purpose. For the French king himself, who has raised the majesty of a crowned head so high, did not think it beneath the grandeur of so great a monarch to order the publication of the English remedy, as the French called the Peruvian bark, which, at a great rate, he purchased from *Talbot*, an English empirick, famous for his many and speedy cures of quartans, and other agues. By the authority of the same prince, who has been a great encourager of divers parts of learning, there has been some years since settled at Paris a society or assembly of physicians, chirurgions, and others, whose main business is to keep correspondency in several parts, and receive informations of the novelties that occur about diseases, and impart to the public such, as they shall think worthy and seasonable; which communications consist not only of new discoveries, odd cases, speculations and observations, but of receipts and processes of remedies, printed for the most part in French, the common language of the people; divers of which remedies have, upon trial, been found useful, as well in *England* as in *France*. There has been also lately in that kingdom a book printed more than once, that makes yet for my purpose. For there has been published in the French tongue a large collection of receipts, for almost all diseases, placed in alphabetical order; and though these receipts are circumstantially delivered in the mother-tongue of the people, yet they came not forth without the licence or authority of the faculty of physic; and were (at least the first tome) so well received and approved, that in divers places the respective bishops authorised them by their public approbation, and recommended them upon the account received, or the good effects they had produced, both to the other charitable persons, and to the curates (or parish-priests) in their dioceses.

In complying with the desires of many, and with the dictates of philanthropy, I hope, I may procure my medicinal receipts and processes the more favourable reception, if I shew, that I might justly have a peculiar and personal repugnancy to this work. For many may think it strange, as I myself have been prone to do, that I should presume to recommend medicines to others, who, for divers years, have been so infirm and sickly myself; and some it is like will upbraid me with *Medice, cura teipsum*. But on this occasion, I may represent, that being the thirteenth or fourteenth child of a mother, that was not above 42 or 43 years old when she died of a consumption, it is no wonder I have not inherited a robust, or healthy constitution. Many also have said, in my excuse, as they think, that I brought myself to so much sickness by over much study. But, I must add, that though both the forementioned causes concurred, yet I impute my infirm condition more to a third than to both together; for the grand original of the mischiefs, that have for many years afflicted me, was a fall from an unruly horse into a deep place, by which I was so bruised, that I feel the bad effects of it to this day. For this mischance happening in *Ireland*, and I being forced to take a long journey before I was well recovered, the bad weather I met with, and the as bad accommodation in Irish inns, and the mistake of an unskilful or drunken guide, who made me wander almost all night upon some wild mountains, put me into a fever and a dropsy, (*viz.* an anasarca;) for a compleat cure of which, I past into *England* and came to *London*; but in so unlucky a time, that an ill-conditioned fever raged there, and seized on me among many others: and though, through God's goodness, I at length recovered, yet left me exceeding weak for a great while after; and then, for a farewell, it cast me into a violent quotidian or double tertian ague, with a sense of decay in my eyes,

which during my long sickness, I had exercised too much upon critical books stuffed with Hebrew, and other eastern characters. I will not urge, that divers have wondered, that a person in such bad circumstances, by the help of care and medicines, (for they forget what ought to be ascribed to God) should be able to hold out so long against them. But this, after the foregoing relation, may well be said, that it need be no great wonder, if after such a train of mischiefs, which was succeeded by a scorbutick cholick, that struck into my limbs, and deprived me of the use of my hands and feet for many months, I have not enjoyed much health, notwithstanding my being acquainted with several choice medicines; especially since divers of these I dare not use, because by long sitting, when I had the palsy, I got the stone, voiding some large ones (as well as making bloody water) and by that disease so great a tenderness in my kidneys, that I can bear no diureticks, though of the milder sort; and that I am forced to forbear several remedies for my other distempers, that I know to be good ones, and amongst them divers, that, by God's blessing, I have successfully tried on others. This short narrative may, I hope, suffice to shew, that my personal maladies and sickness cannot rightly infer the inefficacy of the medicines I impart or recommended; and if it shew that, it will do all that was aimed at by this representation.

If some receipts or processes (for I hope they will not be many) should happen to be met with in the following collection, that may be also found either in some printed book or other, it is hoped an indulgent reader will either excuse or pardon that venial fault; especially if we consider, first, that neither physick nor chymistry being my profession, I did not think myself obliged to peruse any store of medicinal books, and therefore may well be supposed to be unacquainted with a great many of them, much more with many of their receipts and processes. And indeed I find by some of the latter printed catalogues of books written about the physicians art, that there is a multitude of them, which, when I wrote, I had never seen, or perhaps so much as heard of. Secondly, that it is so usual for authors, especially that write either systems or collections, to set down store of prescriptions dictated by their conjectures, not their trials, and yet without giving a distinct character of almost any of them in particular; that if I had met there with some of the same, that I am speaking of, I should not have selected them from a great number of other undistinguished ones: and it is easy to observe, that there is a great deal of difference betwixt being told by an author, that many things, and among the rest, but not before them, this or that drug, or receipt, is good for such a disease, and to have particular notice given of it; and not only to be confirmed, that it is good, but to be told how good it is, and possible also, that it may be usefully employed in other distempers besides those, for which it is prescribed in the printed book.

THE most of these receipts are intended chiefly for the use of those, that live in the country, in places where physicians are scarce, if at all, to be had, especially by poor people. And because very frequently a labouring-man, or a handicraftsman, or some tradesman, has a whole family depending upon him, being maintained by his pains and industry, and yet is disabled to help himself and them, not by any internal, but oftentimes accidental maladies; such as bruises, strains, cuts, tumours, aches, burns, and the like; I have been careful to furnish this final collection with a pretty number of good receipts, obtained most of them from able surgeons and practitioners for those external accidents, that those poor upholders of families, who cannot find or see a surgeon, or a doctor, may be cheaply relieved without either of them.

The AUTHOR'S Introduction to the FIRST VOLUME.

THE following prescriptions are a part of a collection of receipts and processes, that from time to time have been recommended to me by the experience of others, or approved by my own; receipts, that being parable or cheap, may easily be made serviceable to poor country people.

For medicines so simple, and for the most part so cheap, I have found all of them to be good in their kind; and though I think most of them safer than many other medicines, that are in great request, yet I do not pretend, that these should play the part of medicines and physicians too; but that they may be usefully employed by one who knows how to administer them discreetly.

I distinguish them into three classes or orders, annexing to the title of each particular medicine one of the three first letters of the alphabet; whereof *A* is the mark of a remedy of the highest class of these, recommended as very considerable and efficacious in its kind. *B* denotes a second or inferior sort, but yet to be valuable for their good operation. *C* belongs to those remedies that are of the lowest order, though good enough not to be despised.

THOSE receipts, which were my own, are expressed in my own terms; so also those, which I received from others by word of mouth: but them, which were imparted to me in writing, though I myself would not have worded them as they did that I had them from, yet I oftentimes made a scruple to correct or alter their expressions, though not suitable to the current style of the formularies of receipts; being more concerned, that the meaning should be close kept to, than the style rectified.

Mr. BOYLE'S RECEIPTS.

D E C A D I.

I. *For Coughs, especially such as proceed from thin rheums.*

TAKE of choice *olibanum* finely powdered, from one scruple to half a dram; and mix carefully with it an equal weight of sugar-candy, (white or brown) or, in want of that, of fine sugar; and let the patient take it at bed-time in the pulp of an apple, or some other proper additament, for several nights together: if it be found needful, it may be taken at any other time, when the stomach is empty.

II. *To give ease in the pains of the Stone, even that of the bladder.*

TAKE the transparent sparr, that grows upon veins of lead-ore, and having reduced it to fine powder, give from half a dram to a whole dram of it at a time, in a moderate draught of some convenient vehicle. *N. B.* Though there be (at least in most of our *English* mines) two teguments, as it were, of the veins of lead, that grow close together; yet that, which the diggers name cawke, which is white and opacous, is not the medicine I mean; but the transparent, or at least semi-diaphanous, which easily breaks into smooth fragments, and in the fire cleaves into several pieces, that are wont to be smooth and prettily shaped.

III. *For Sharpness of Urine.*

B TAKE of the dry stuff, that divides the lobes of the kernels of walnuts, beat them to powder, and of this give about half a dram at a time, in a draught of white-wine or posset-drink made with it, or in any other convenient liquor.

IV. *To appease the violent pains of the Tooth-ach.*

B MAKE up a scruple of *pilulæ mastichinæ*, and half a grain of *laudanum*, into two or three pills, for the patient to take at bed-time.

V. *For Agues.*

A TAKE salt of *card. benedict.* and salt of wormwood and 15 grains; tartar vitriolate half a scruple; mix them, and give them in a few spoonfuls of Rhenish wine, or of some other convenient vehicle, either before the fit, or at some other time, when the stomach is empty.

VI. *For the Yellow-Jaundice.*

B TAKE an ounce of Castile soap (the elder the better) slice it thin, put it into a pint of small-beer cold, set it on the fire, let it boil gently half away; after boiling some time, scum it once; then strain it through a small sieve, warm it, and drink it all in a morning fasting; take a small lump of sugar after it, and fast two or three hours: the party may walk about his business, and eat his accustomed meals. If at any time he drinks wine, let it be white-wine. *N. B.* If he be far gone in the distemper, two or three days after he may take it once or twice more, and no oftener. Refrain all other medicines; it will keep a week or longer.

VII. *For the Jaundice.*

B TAKE two or three ounces of *semen canabis*, (hemp-seed) and boil them till the seeds (some of them) begin to burst, and a little longer, in a sufficient quantity of new milk, to make one good draught; which the patient is to take warm, renewing it, if need be, for some days together.

VIII. *For the Dysentery.*

B TAKE pig's-dung, dry it, and burn it to grey (not white) ashes; of these give about half a dram for a dose, drinking after them about three spoonfuls of white-wine vinegar.

IX. *For the King's-Evil.*

B TAKE cuttle-bone uncalcined, and having scraped off the outside or coloured part, dry the white part; and of this finely powdered give half a dram for a dose in *aqua malvæ*.

X. *A safe and easy medicine in the fits of the Stone.*

B TAKE sack, or in want of that, claret-wine; and by shaking, or otherwise, mix with it, as well as you can, an equal quantity of oil of walnuts; and of this mixture give from four or six, to eight or ten ounces at a time, as a clyster.

D E C A D II.

I. *For Convulsions, especially in Children.*

TAKE earth-worms; wash them well in white-wine to cleanse them, but so, as that they may not die in the wine: then upon hollow tiles, or between them, dry the worms with a moderate heat, and no further, than that they may be conveniently reduced to powder; to one ounce of which add a pretty number of grains of ambergrease, both to perfume the powder (whose scent of itself is rank) and to make the medicine the more efficacious. The dose is, from one dram to a dram and a half in any convenient vehicle.

II. *For the Piles.*

TAKE the powder of earth-worms prepared as in the former receipt (but leaving out the ambergrease;) and incorporate it exactly with as much hen's-grease, as will serve to make it up into an ointment. Apply this to the part affected, whose pains it usually much and safely mitigates.

III. *To make Lime-water useful in divers distempers.*

TAKE one pound of good quick-lime, and slack it in a gallon of warm water, and let it stand, till all that will subside be settled at the bottom, and (separation being made) the water swim clear at the top; (at which time it will often happen, that a kind of thin and brittle substance, almost like ice, will cover the surface of the liquor;) as soon as the water is thus sufficiently impregnated, delay not to pour it off warily, and keep it well stopp'd for use.

IV. *A Lime-Water for Obstructions and Consumptions.*

TAKE a gallon of lime-water made as above, and infuse in it cold saffras, liquorice, and anniseeds, of each four ounces, adding thereto half a pound of choice currants, or the like quantity of sliced raisins of the sun: the dose of this compound lime-water is four or five ounces, to be taken twice a day.

V. *An Amulet against Agues, especially Tertian.*

TAKE a handful of groundsel, shred and cut it small, put it into a square paper bag of about four inches every way, pricking that side, that is to be next the skin, full of large holes; and cover it with some sarsenet or fine linnen, that nothing may fall out. Let the patient wear this upon the pit of his stomach, renewing it two hours before every fit.

VI. *For Women in Labour to bring away the Child.*

TAKE about one dram of choice myrrh, and having reduced it to fine powder, let the patient take it in a draught of Rhenish wine or sack; or if you would have the liquor less active, white-wine, posset-drink, or some other temperate vehicle.

VII. *For strengthening the Bowels.*

TAKE cloves or chives (not bulbs) of garlick, and let the patient from time to time swallow one or two, without chewing.

VIII.

VIII. *An amulet against the Cramp.*

A TAKE the root of mechoacan, and having reduced it to powder, fill with this powder a little square bag or sacket of sarcenet, or some such slight stuff; which bag is to be about three inches square, and to be hung by a string about the patient's neck, so that it may reach to the pit of the stomach, and immediately touch the skin.

IX. *For stanching of Blood, especially in Wounds.*

A TAKE those round mushrooms, that botanists call *crepitus lupi* (in English puff-balls) when they are full ripe (which is in autumn) and breaking them warily, save carefully this powder, that will fly up, and the rest, that remains in their cavities; and strew the powder all over the part affected, binding it on, or proceeding further, if need be, according to art.

X. *For Tumours and pains of the Hemorrhoids, not too much inflamed.*

B LET the patient dip his finger in balsam of sulphur made with oil of turpentine, and with his finger so besmeared, anoint the tumours, whether external or internal, once or twice a day.

D E C A D III.

I. *For the Dysentery, and other sharp Fluxes.*

B TAKE the stalks and leaves of the herb called in Latin *coniza medina*, (in English flea-bane) dry it gently, till it be reducible to powder; of this powder give about one drachm at a time, twice or thrice a day, in any convenient vehicle; or else incorporate it in conserve of red roses.

II. *To sweeten the Blood, and cure divers Diseases caused by its Acidity.*

B TAKE coral, the clearest and reddest you can get; reduce it (by exactly grinding it on a porphyry or marble stone) to an impalpable powder. Of this magistery made without acids, give the patient once or twice a day, (as need shall require) a large dose, ordinarily about one drachm at a time, or from two scruples to five. N. B. Let him long continue the use of it.

III. *To clear the Eyes, even from films.*

A TAKE Paracelsus's *zebethum occidentale*, (*viz.* human dung) of a good colour and consistence; dry it slowly, till it be pulverable; then reduce it into an impalpable powder; which is to be blown once, twice, or thrice a day, as occasion shall require, into the patient's eyes.

IV. *For Convulsions in children.*

A GIVE the patient from two, three, or four, to five, six, or seven grains, according to the child's age, of the true volatile salt of amber, in any proper vehicle. N. B. It is not so efficacious in full grown persons.

V. *To*

V. *To bring away the After-birth.*

B GIVE about thirty drops, or any number between twenty-five and thirty-five of good essential (as chymists call it) oil of juniper, in a good draught of any convenient vehicle.

VI. *To strengthen the Stomach, and help the want of Appetite.*

B MAKE the roots of gentian (sound and not superannuated) pulverable, with no more waste of the moisture than is necessary. Reduce these to powder, of which let the patient take from twelve or fifteen grains, to double that quantity (or more if need be) twice or thrice a day. *N. B.* It may be taken on an empty stomach, or, if that cannot conveniently be done, at meal-times. To correct the bitterness, one may add to it powdered sugar, or make it up with some fit conserve, or mix it with a syrup. It is very good, not only for want of appetite, but for obstructions. And *I (R. B.)* have usually given it in vertiginous affections of the brain, and to lessen, if not quite take away, the fits of agues, and even quartans. But, in this last case, the dose must be considerably augmented. One may also, if one pleases, instead of the powder, give the extract drawn with fair water, and for those that like that form, made up into pills with a sufficient quantity of powdered turmeric, or the like proper additament; to which I have sometimes added some grains of salt of wormwood with good success, in fluxes, that proceeded from crudities and indigestion. Where the winter season, or the patient's cold constitution invite, or the medicine is to be long kept, I chuse rather to make the extract with wine moderately strong, than with water.

VII. *For Ulcers in the Breast, and elsewhere.*

A TAKE millepides (in English by some called wood-lice, by others fows) and having washed them clean with a little white wine, and dried them with a linen cloth, beat them very well in a glass or marble mortar, (for they ought not to be touched with any thing of metal) and give the first time as much juice as you can by strong expression obtain from five or six of them. This juice may be given in small ale or white wine, in which the next time you may give as much, as can be squeezed out of eight or nine millepides; and so you may continue increasing the number, that you employ of them, by two or three at a time, till it amount to twenty-five or thirty; and if need be, to forty or more, for one taking. And note, that if, upon pounding of these insects, you find the mass they afford too dry, as it now and then happens; you may dilute it with a little white wine or ale, to be well agitated with it, that being penetrated and so softened with the liquor, the mass may the better part with its juice.

VIII. *For taking off the Fits of Agues.*

TAKE good common brimstone (not *flores sulphuris*) and having reduced them, by passing them through a very fine sieve, to the subtilest powder you can, give of this powder one drachm and half, or two drachms, either made up into a bolus with a little good honey, or else in any appropriated vehicle; let it be given at the usual times, and reiterated once or twice, if need be, especially if the fits should return.

IX. *For Fluxes, especially accompanied with Gripings.*

TAKE of crude lapis calaminaris finely powdered two scruples, of white chalk one scruple; mix them exactly, and give them in a spoonful or two of new milk twice, or, if the case be urgent, thrice a day.

Mr. BOYLE'S RECEIPTS.

X. *For the Pains of the Piles.*

B TAKE of myrrh, olibanum, and common frankincense, of each a like quantity; having powdered them, mix them very well, and let the patient receive the fume of this mixture, cast upon a chaffing-dish with embers, in a close-stool, for about a quarter of an hour (less or more, as he needs it, and is able to bear it).

DECAD IV.

I. *For an outward Contusion.*

A PPLY to the part affected skim'd or purified honey, spread upon cap-paper, to be kept on with some convenient plaister, or the like bandage, and shifted once or twice a day.

II. *Another of the same.*

A BEAT aloes succotrina (or else hepatica) to fine powder; then pour on it as much rose-water, as you guess may dissolve a great part of it: this done, stir them well for a while, and, when the mixture is settled, pour off the liquor, and in it dip linen rags, which being applied to the part affected will soon stick to it, and seldom need be removed till the patient be relieved; and then to get them off, the rags must be well wetted with warm water, which will soften and loosen the adhering aloes.

III. *For a slighter Excoriation.*

B MELT mutton suet taken from about the kidneys, and freed from its superfluous fibres or strings; and to about two ounces of this add, little by little, about sixteen or eighteen drops (sometimes eight or ten may serve) of oil (not æthereal spirit) of turpentine; spread this mixture on a linen cloth, and, by binding or otherwise, keep it upon the part affected.

IV. *For an Excoriation, when the true Cutis is affected.*

B TAKE prunella (in English self-heal) and having pounded it very well in a marble or glass mortar (not one of metal) apply it to the part affected, renewing it but seldom, and not without need.

V. *To take off the Pain and Inflammation of Ulcers in the Legs and elsewhere.*

B IN a quart of water boil about so much white bread, as in ordinary years may be found in a halfpenny loaf; then add to it two ounces of good sheep suet cut very small; and when that is boiled a little, add to it one ounce of finely powdered rosin, and a little well fearfed brimstone: of these make a cataplasim, which is to be kept constantly on the part affected, and shifted once or twice a day, as need shall require.

VI. *For a Cough, especially accompanied with a tickling Rheum.*

B TAKE equal parts of finely powdered olibanum and venice-treacle, incorporate them exactly, and of this mass form pills of what bigness you please: of these let the patient take about half a drachm at bed-time, or, if need be, one scruple (or more) twice a day.

VII. *To*

VII. *To prevent the Tooth-ack, and keep the Teeth sound.*

B Let the patient frequently rub his teeth moderately with the ashes that remain in tobacco-pipes, after the rest of the body hath been consumed in smoak; some time after, washing (if need be) his mouth with fair water not too cold.

VIII. *For a Rupture, especially in a Child or young Person.*

A TAKE of that geranium or crane's bill, that is commonly called columbinum, reduce the root and leaves to fine powder, and of this let the patient take about half a spoonful at night and morning for three or four weeks together, washing it down each time with some spoonfuls of red wine.

IX. *For the Heart-Burning, as they call it.*

B TAKE from fifteen or twenty, to thirty or forty grains of crabs-eyes (known commonly in the shops by the name of lapides cancrorum) reduced to very fine powder, and either take it alone, or in any convenient conserve or syrup. It is for the most part best to take this medicine when the stomach is empty.

X. *For a Strain.*

B TAKE the strongest vinegar you can get, and boil in it a convenient quantity of wheat-bran, till you have brought it to the consistence of a poultice. Apply this as early as may be to the part affected, and renew it when it begins to grow dry.

DECAD V.

I. *For a recent Strain.*

B TAKE wormwood, and pound it very well in a mortar of stone or glass; then put into it as much of the whites of eggs beaten to water, as may serve to make it up into such a consistence, as may be applied like a poultice to the part affected.

II. *A strengthening Plaister after a Strain, or when there is any Weakness in the Joint.*

B MELT down together, and incorporate very well, two parts of *diapalma*, and one part of *emplastrum ad berniam*; spread this mixture (but not very thick) upon leather, and lay it to the joint to be strengthened.

III. *For Loosenesses.*

C BOIL a convenient quantity of cork in spring-water, till the liquor taste strong thereof; of this decoction let the patient drink a moderate draught from time to time, till he finds himself relieved by it.

IV. *For Obstructions, and divers Diseases proceeding thence.*

B LET the patient drink every morning a moderate draught of his own urine newly made, and (if it can conveniently be) whilst it is yet warm, forbearing food for an hour or two after it.

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V. *For Difficulty of Hearing, from a cold cause.*

B OUT of a bulbe, or root of garlick, chuse a chive of a convenient bigness; then having passed a fine piece of thread or silk through one end of it, that thereby it may be pulled out at pleasure, crush it a little between your fingers, and having anointed it all over with oil of bitter, (or, for want of that, sweet) almonds, put it into the cavity of the patient's ear at bed-time, and draw it out the next morning, stopping the ear afterwards with black wool; but if need require, this operation is to be reiterated with fresh garlick for some days successively.

VI. *For Ruptures in the Belly, especially in Children.*

A HAVING well cleansed the roots of sigillum Salamonis, scrape one ounce of them into a quart of broth, and let the patient take a mess, or a porringer full of it for his breakfast; or else give half a drachm, or two scruples, of the powder of it at a time in any convenient vehicle.

VII. *To give check to Fits of the Gout, and in some measure to prevent them.*

B TAKE three ounces of sarsaparilla sliced and cut thin; to these add an equal weight of raisins of the sun, rubbed very clean, but not broken; put both these ingredients into three quarts of spring water, and let the vessel stand in a moderate heat, that the liquor may simmer for many hours, yet without bursting most part of the raisins; keep this decoction well stoppt, and let the patient use it for his only drink, till he need it no longer.

VIII. *A Water for Ulcers and Sores.*

B TAKE a solution of Venetian sublimate, and having made with very good quicklime as strong a lime-water as you can, (so that, if it be possible, it may bear an egg) drop this upon the dissolved sublimate, till it will precipitate no more reddish stuff at all; (which will not so soon be done, as one, that hath not tried, will imagine:) as soon as you perceive, that the liquors act no longer visibly upon one another, pour the mixture into a filter of cap-paper, which, retaining the orange-coloured precipitate, will transmit an indifferently clear liquor, which is to be in a glass vial kept stoppt for its proper use; namely, that the part affected may be therewith washed from time to time, and, if need be, kept covered with double linen cloths wetted in the same liquor.

IX. *A Plaister to discuss Tumours, and ripen them, if it cannot discuss them.*

B TAKE of yellow wax, frankincense, and rosin, of each four ounces, or a sufficient quantity; melt them together gently, and being strained, make up the mass into a roll for use.

X. *For the Black Jaundice itself.*

B TAKE a spoonful of honey, boil it gently, and scum it, till it come to a good consistence: then add of wheat-flour and saffron (reduced to a powder) as much of each, as you may take upon the point of a knife; and having mixed all well, put it over the coals again, until it lose its smell; afterwards you may put it into a little stone or earthen pot, and keep it for use; which is, that the patient take the quantity of a pea, and anoint the navel, and fill the cavity thereof with it; repeating the application for some days together, when the stomach is empty, and abstaining from meat and drink about two hours after the medicine is used.

DECAD VI.

I. *A parable Medicine for the Stone.*

TAKE of the seed of fixwood, and give of it about as much, as will lie upon a shilling, either whole or grossly bruised, in any convenient vehicle.

II. *For Fits of the Mother.*

DISSOLVE store of sea-salt in the best wine-vinegar, and in this dip a soft linen cloth, which being folded so as to make three or four doubles, is to be applied somewhat warm to the sole of the patient's feet, and kept on till the fit be over.

III. *A choice Plaister to strengthen the Joints after the Gout, and hasten the going off of the Pain.*

TAKE of Paracelsus and diapalmaana, melt them and incorporate them exactly together, and spread the mixture very thin upon fine leather, to be used as a plaister to the part affected.

IV. *A very good Drink in continual Fevers.*

MAKE a decoction of the leaves of rue in fair water, till the liquor taste pretty strong of the plant; this being strained, is to be made somewhat palatable with liquorice, or a little sugar, or aromatic body; to half a pint of this add about ten drops of spirit (not oil) of vitriol: let the patient use this for his ordinary drink.

V. *A good Drink, to be frequently used in Fevers, especially continual ones.*

GIVE in half a pint of some small convenient drink, half an ounce of hartshorn, burnt to great whiteness, which is to be a little boiled in the liquor; and this, thus altered, is to be given from time to time.

VI. *An easy Medicine for a fresh Strain.*

MAKE up the clay, with which the bungs of barrels are wont to be stoppt, with as much vinegar, as will bring it to the consistence of an indifferently stiff cataplasm: then warm it a little, and apply it to the part affected.

VII. *A Remedy much used for Chilblains.*

TAKE a turnip, roast it well under the embers, and beat it to a poultice; then apply it very hot to the part affected, and keep it on (if need be) for three or four days; in that time shifting it twice or thrice, if occasion require.

VIII. *A simple antimonial Remedy, that has often done much good even in the Leprosy, and all continual Fevers.*

TAKE crude antimony, well chosen and powdered; of this give about one, two, or three scruples morning and evening, according to the age of the patient, in a little syrup of clove-gilly-flowers, or any such vehicle, or else mixed with fine sugar, enough to make it somewhat palatable. This may be continued for four or

five months, if need require; and if the first dose prove beneficial to the patient, in cases not urgent, a scruple or half a drachm may serve the turn, nor need the exhibition be continued for so long a time.

IX. *For the Cholick and divers other Distempers.*

B TAKE four or five balls of fresh stone-horse dung, and let them steep for about a quarter of an hour (or less) in a pint of white-wine, in a vessel well stoppt, that the liquor may be richly impregnated with the more volatile and subtile parts of the dung; strain this, and give of it from a quarter to half a pint, or some ounces more at a time, the patient having a care not to take cold after it.

X. *An often experienced antimonial Infusion.*

B TAKE one ounce of powdered antimony tied up in a little bag of clean linen, and hang it in a gallon of beer or ale, that is brought from the brewhouse, and is yet scarce fit to be drawn out, much less to be drank. Of this liquor, when it is ripe, let the patient make use for his ordinary drink; only having a care, that if by age or accident it be perceived to grow sour, that vessel then be left off, for fear lest the acidity of the liquor corroding the antimony might make it vomitive.

D E C A D VII.

I. *An easy Medicine to cleanse the Womb, especially after Child-bearing.*

B TAKE a large white onion, of about four ounces in weight, (if you can get so big a one, and boil it in about a pint of water, with any thing fit to make a very thin broth, till a third part or more of the liquor be consumed: of this broth, which may be made a little palatable with nutmeg, &c. the patient is to take six or eight ounces twice or thrice a day.

II. *An experienced Wash, that quickly Cures the Itch.*

A TAKE strong quick-lime, one pound, and put to it a gallon of spring-water; let them lie together for some hours, and then warily pour off the clearer; filter the rest, and take two ounces of quicksilver, tied up in a linen bag, and hang it in the liquor, and boil it for half an hour or more; then pour off the clear liquor once more, and wash the hands only with it twice, or at most thrice a day.

III. *A Remedy often used with Success in Fluxes, and even Dysenteries.*

B. TAKE fresh roots of bistort, cut them into thin slices, and moisten them well with fair water and wine, to make them more soft and succulent; then press out the juice as strongly as you can; and of this give about three or four spoonfuls mingled with half a dozen spoonfuls, or somewhat more, of red wine, or some other convenient liquor.

IV. *A good Medicine for a Sore Throat.*

B TAKE the white of a new-laid egg, and, by beating it, reduce it into water; and with this water mix diligently so much conserve of red roses, as will reduce it to a soft mass; whereof the patient is to let a little bit at a time melt leisurely in his mouth.

V. *A choice Medicine for a Sore Throat.*

A TAKE a piece of greasy linen cloth, of such a bigness, as, that being doubled, may make a bag in form of a stay, to reach from one side of the throat to the other, and contain as much matter, as may make it of the thickness of an inch or more: this bag being filled with common salt, is to be heated thoroughly, and applied to the part affected as warm as the patient can conveniently endure; and within two hours after, or when it begins to grow too cold, another like it, and well heated, is to be substituted in its room; and whilst this is cooling, the other may be heated, and made ready for use: so that the part affected may be always kept in a considerable degree of warmth, for about 48 hours, if the remedy be so long needed.

VI. *An often experienced Medicine for the Cholic, especially produced by sharp Humours.*

A TAKE a quart of claret, and put into the vessel about two ounces of nettle-seeds, stop the bottle, and keep it in boiling water, till the water has made three or four warms, to assist the wine's impregnation with the finer part of the seeds: of this liquor let the patient take a small draught once or twice a day.

VII. *To appease the Pain of the Hemorrhoids, whether internal or external.*

B TAKE two parts of flower of sulphur, and one part of sugar very finely powdered, mix them exactly together, and make them up with a sufficient quantity of mucilage or gum trajacanth into lozenges of about a drachm a-piece: of which you may give one at a time thrice a day, or, if need be, four or five times.

VIII. *To make an excellent Drink for the Scurvy.*

A TAKE two handfuls of water-trefoil, and let it work in about eight gallons of wort instead of hops, or of small-ale or wort, made for it; and let the patient use it for all, or for a great part of his ordinary drink.

IX. *To make an easy Diuretic.*

C PEEL off the inner skin of an egg-shell, then beat the shell to a very fine powder: give about a scruple of it at a time in any convenient vehicle.

X. *A powerful Application to prevent and check the Apoplexy.*

A MAKE an issue at the meeting of the sutures, and keep it open for a good while: but if the case will not admit a delay, clap on a good cupping-glass, without scarification, or with it, as need shall require, upon the same concurrence of the sutures.

DECAD VIII.

I. *A choice Medicine for a Sore Throat.*

A TAKE housleek, and having lightly beaten it in a glass or stone mortar, press out the juice hard between two plates; to this juice put almost an equal quantity of virgin-honey, mix them well, and add to the mixture a little burnt allum, as much as is requisite to give it a discernible aluminous taste: let the patient take this from time to time, with a liquorish stick, or some such thing.

II. *An*

II. *An approved Medicine for a Cancer not broken.*

B TAKE dulcified colcothar, and, with cream of whites of eggs beaten to a water, bring it to the consistence of a cataplasm; which ought to be made large, and spread about the thickness of half a crown, and applied warm to the part affected, shifting it at least once a day.

III. *To make a very good Syrup for thin Rheums.*

A TAKE syrup of jujubes, syrup of dried roses, and syrup of corn poppy-flowers, of each a like quantity, mix and use them as the necessity of the sick requires.

IV. *For the Dysentery and Plurisy.*

B GRATE to fine powder the dried pizzle of a stag, and give of it as much as will lie upon a shilling or thereabouts, once or twice a day, in any convenient vehicle.

V. *To strengthen the Gums, and make the Teeth grow fine.*

B TAKE catechu, terra Japonica, or Japonian earth, and dissolve as much as you can of it in a pint of claret, or red wine; then decant the liquor warily from the subsiding fæces, and let the patient now and then wash his mouth with it, especially at bed-time.

VI. *For a Hoarseness upon a Cold.*

B TAKE three ounces of hyssop-water, sweeten it with sugar-candy; then beat well into it the yolk of an egg, and drink it at a draught.

VII. *A choice Medicine for the Jaundice in Children.*

A TAKE half an ounce of choice rhubarb made into powder; incorporate with it exactly, by long beating, two handfuls of well chosen and cleansed currants. Of this electuary let the patient take every morning about the quantity of a nutmeg, for several days together.

VIII. *A rare Medicine to take away gouty, or other arthritick Pains.*

A TAKE highly rectified spirit of man's urine, and anoint the part with it, the cold being just taken off, once or twice the first day, and no longer, unless the pain continue.

IX. *For a Prolapsus Uteri.*

B APPLY to the patient's navel a pretty large cupping-glass; but let it not stay on too long, nor above a quarter of an hour, for fear of injuring the part it covers, especially the navel-string.

X. *To allay Heat in the Eyes proceeding from sharp Humours.*

B BEAT the white of an egg into a water, in which dissolve a pretty quantity of refined loaf-sugar, and then drop some of it into the patient's eye.

D E C A D IX.

I. *An experienced Medicine for strengthning a weak Sight.*

B TAKE of eye-bright, sweet fennel-seeds, and fine sugar, all reduced to powder, of each an ounce, nutmeg also pulverised, one drachm (at most;) mix these very well together, and take of the composition from one drachm, to two or more, from time to time.

II. *An often tried Medicine for tertian Agues.*

B TAKE crude allum and nutmeg finely scraped, of each about half a drachm, mix the powders well together, and with about six grains of saffron: give this in two or three spoonfuls of white-wine vinegar, at the usual time.

III. *For stuffing of the Lungs, and the Chincough.*

B MAKE syrup of penny-royal, or of ground-ivy, moderately tart with oil of vitriol; and of this let the patient take very leisurely about a quarter of a spoonful from time to time.

IV. *For the Falling-sickness in Children.*

B TAKE half a drachm of choice amber, finely powdered, and give it for six or seven weeks together, once a day, when the stomach is empty, in about four ounces of good white-wine.

V. *An approved Medicine to drive the Stone, and cure Suppression of Urine proceeding from it.*

A TAKE the roots of wild garlick (by some country people called crow garlick) wipe them very clean, stamp them very well in a mortar of stone or glass, and strain out the juice; with which make a moderate draught of good white-wine considerably strong, and let the patient take it once or twice a day.

VI. *An experienced Medicine for Sore Throats.*

A TAKE of scabius water six ounces, of wine-vinegar a small spoonful, of mustard-seed beaten, and of honey, of each a spoonful; and stir and shake them very well together; and then filter the mixture, and keep it for use.

VII. *An often experienced external Remedy in Apoplectic Fits.*

A FIX a cupping-glass (without scarification) to the nape of the neck, and another to each of the shoulders, and let them stick on a competent time.

VIII. *An easy, but approved Medicine for the Cholick.*

B TAKE about half a drachm of mastick, and mix it with the yolk of a new-laid egg, and give it to the patient once or twice a day.

IX. *To appease the Heat of Fevers by an external Remedy.*

C APPLY to the soles of the feet a mixture or thin cataplasm made of the leaves of tobacco, fit to be cut to fill a pipe with, beaten up with as much of the freshest currants you can get, as will bring the tobacco to the consistence of a poultice.

X. *The Medicine, that is in such request in Italy, against the Worms in Children.*

B INFUSE one drachm of clean quick-silver all night, in about two ounces of the water of goats rue, distilled the common way in a cold still: and afterwards strain and filter it, to sever it from all dregs that may happen in the making it. This quantity is given for one dose.

D E C A D X.

I. *A choice Medicine for a Whitloe.*

A TAKE snail-shells, and beat the pulpy part of them very well, with a convenient quantity of fine chopped parsley, which is to be applied warm to the affected part, and shifted two or three times a day.

II. *A simple but useful Lime-water good for the King's-evil, and divers other Causes.*

B TAKE half a pound of good quick-lime, and put it into one gallon of spring-water, and infuse it for twenty-four hours; then decant the liquor, and let the patient drink a good draught of it two or three times a day, or he may use it for his ordinary drink; this infusion may be coloured with saffron or red-sanders; and, if need be, to make it stronger, add more lime, and warm the water and keep it well stopped.

III. *An excellent Medicine for a fresh Strain.*

A TAKE four ounces of bean-flower, two ounces of wine-vinegar; of these make a cataplasm to be applied a little warm to the part affected; but if this should prove something too sharp (as in some cases it may) then take two drachms of litharge, and boil it a little in the vinegar before you put in the bean-flower.

IV. *For the Piles.*

A TAKE balsam of sulphur made with oil of turpentine, ointment of tobacco, equal parts, incorporate them well, and anoint the grieved place therewith.

V. *For a Burn.*

B MINGLE lime-water with linseed-oil, by beating them together with a spoon, and with a feather dress the burn several times a day.

VI. *For a fresh Strain.*

A BOIL bran in wine-vinegar to the consistency of a poultice, apply it warm, and renew the poultice once in twelve hours for two or three times.

VII. *An*

VII. *An experienced Medicine for the Cholick.*

A TAKE good nitre, one ounce, and rub it well in a clean mortar of glass or stone; then grind it with half a scruple or more of fine saffron; and of this mixture give about half a drachm for a dose, in three or four ounces of cold spring-water.

VIII. *To make an Issue raw, that begins to heal up.*

B TAKE of *lapis infernalis* one ounce, of crown-soap an ounce and an half, chalk finely powdered six drachms, mix them all together carefully, and keep them close stopped, except when you mean to use them.

IX. *For a Sore Throat.*

A MAKE a plaister of *Paracelsus*, three or four fingers broad, and length enough to reach almost from one ear to the other, and apply it to the part affected, so that it may touch the throat, as much as may be.

X. *For Heat about the Orifice of the Stomach.*

B MAKE a syrup with the juice of houseleek and sugar, and give about one spoonful of it from time to time.

XI. *A Stomachical Tincture.*

A TAKE agrimony, two drachms, small centuary-tops, one drachm, coriander-seeds bruised, one scruple, saffron-shavings and bark, one drachm, gentian-root, half a drachm, zedoary-root, ten grains; pour upon these three quarters of a pint of boiling spring-water, cover it, and let it steep twelve hours, then strain it, and put it in a bottle; then drop a drop of oil of cinnamon upon a lump of sugar, and put it into the liquor. The dose is three spoonfuls twice a day, an hour or two before meals.

The End of the First Volume.

M E D I C I N A L E X P E R I M E N T S :

O R, A

C O L L E C T I O N

O F

C H O I C E a n d S A F E R E M E D I E S

V e r y U s e f u l i n a l l F A M I L I E S .

T H E S E C O N D V O L U M E .

I. *A powerful Remedy in Apoplectic Fits.*

TAKE the herb mastick, and distill, by an alembic, with a copper body, an essential oil, of which, with such a pipe or quill, that one end may be opened and stopped at pleasure, (the other still remaining open) blow up some drops first into one of the patient's nostrils, and a while after into the other too.

II. *A good Plaister for Acks, especially scorbutical.*

SPREAD thinly upon flink, or very fine kids leather, the *emplastrum de mucilagibus*, and let it lie upon the aching part as long as there is need.

III. *For an old Ack or Strain..*

TAKE of *Lucatella's* balsam one ounce, of oil of turpentine one dram, incorporate them very well with a gentle heat, and anoint the part affected therewith, wearing on it a piece of unwashed flannel besmeared with the same ointment.

IV. *For Scorbutic Acks, especially about the shere-bone.*

TAKE two parts of palm-oil, and one of oil of camomile (to which, if you please, you may add a little ointment of elder) mix these exactly, and anoint the part affected.

V. *A powerful Remedy for Scorbutic Acks.*

TAKE to one ounce of oil of turpentine, one dram or two of the volatile salt of harts-horn, or as much as being well ground with it in a mortar of glass or marble, will bring it to the consistence of a kind of ointment, with which, the cold being taken off, the part affected is to be lightly anointed.

VI. *A very easy Medicine for light scorbutic Acks or Pains.*

ANOINT the pained part from time to time with fasting-spittle; and if you will have the medicine a little stronger, the patient may put roch-allum to the bigness of a small pea into his mouth before he employs his spittle.

I

VII. *For*

VII. *For Aches and pricking Pains in the sides or elsewhere.*

WITH a sufficient quantity of clean sulphur finely powdered mix diligently as much Venice treacle as will bring it to the consistence of pills. Of this mixture you may give the quantity of a pistol-bullet twice, or, at most, thrice a day, drinking any convenient liquor after it.

VIII. *An experienced Remedy for an Anasarca, or general disease of the whole body.*

FRY freshly gathered rue with oil of walnuts, till it become fit to be applied hot as a cataplasm or poultice to the navel; and keep it on that part some hours, renewing it once or twice a day, if need require.

IX. *An external Medicine often successfully tried for Agues.*

TAKE five, seven or nine (for it is pretended it must be an odd number) of the roots of rib-wort, and having made them clean, put them into a little bag of sarsenet or fine linnen, and let the patient wear it upon the nape of his neck, renewing it within two, three, or four days, if need require.

X. *A tried Remedy for Agues.*

TAKE of the bark of sassafras-root, and of Virginian snake-weed, both in powder, of each ten grains; and with half a dram, or two scruples of mithridate or Venice-treacle, or as much as will give it a due consistence, make a bolus to be taken the usual hours.

XI. *A choice Medicine for Aguish Distempers.*

TAKE of salt of wormwood fifteen grains, crabs-eyes, or powder of crabs-claws simple, eight or ten grains; mix these well, and give them in two or three spoonfuls of some cordial water.

XII. *An excellent Wrist-Plaster for Agues.*

TAKE wax, and spread it to about the thickness of a crown-piece of silver, and of a convenient breadth and length to make an entire wrist plaster; upon this spread and display as well as you can the leaves of the tops of rue not yet fully opened by time, so that they may cover the whole plaster as well as you can make them do it. Then apply this emplaister, and let it lie on several days consecutively.

XIII. *An often tried Medicine for Agues.*

TAKE ribwort, gather the leaves as near the root as you can in a dry morning; wipe them clean, but do not wash them; then dry them carefully, till you may reduce them to powder. Of this powder give from one dram or two at most, mixed with one dram of conserve of roses, or the crumbs of white bread, or the yolk of an egg or two. [N. B.] You may, before you dry the leaves, distill a water out of some of them, and make an extract out of others with spirit of wine, or, which is better, with spirit of dew. They are both good for the same disease that the powder is. The dose of the water is one ounce, or an ounce and an half, at the usual times; and that of the extract about one dram in some ounces of white wine.

XIV. *An*

XIV. *An excellent Medicine for Agues, especially Tertians.*

GIVE as much of well-conditioned Virginian snake-root reduced to fine powder, as will lie upon a shilling, in a cup of sherry, just before the beginning of the cold fit, repeating it once or twice, if it need to be used oftner.

XV. *For a Tertian Ague.*

TAKE of the root of angelica grated, or otherwise made into powder, and give of it from half a dram to a dram, in any convenient vehicle at the usual times (*viz.* about two hours before the cold fit.)

XVI. *A Medicine, with which a Quartan was cured, that could not be cured with Jesuits-Bark.*

TAKE one dram of the black tips of crabs-claws, and having reduced them to exceeding fine powder, let the patient take it in any convenient vehicle or conserve, twice or thrice, as he would take the cortex, without intermitting any day.

XVII. *An easy Remedy, which, long continued, does much destroy Acidities or Heart-burnings in the Stomach.*

TAKE half a dram at least of finely powdered red coral, and give it from time to time in any convenient vehicle, till the patient be relieved.

XVIII. *A very often tried Remedy for the Asthma.*

Take soap-boilers lees (made with potashes and quick lime) one part, spirit of wine rectified two parts; set them in digestion (to unite them well) and then add some drops (at discretion) of chymical oil of carraways, and if you please, of anniseeds too. The dose in younger persons is about ten drops, in elder ones, from half a dram to one dram, in some convenient vehicle.

XIX. *An excellent Medicine for a Dry or Convulsive Asthma.*

TAKE choice saffron, reduce it (by rubbing it in a stone or glass mortar) to a kind of powder, and, with any convenient mixture, give eight or ten grains of it in the form of pills at bed-time.

XX. *An experienced Remedy for Difficulty of Breathing.*

TAKE of choice *Castoreum* dried enough to be powdered, two or three, or at most four grains, mix this with ten or eleven grains of *Gascoign's* powder reduced to very fine powder; mix up these with some little syrup or conserve; and when the patient has taken it, let him wash it down with the mixture, consisting of five drams of penny-royal-water, and half a dram, or at most two drams of briny-water compound.

XXI. *An approved Medicine for inveterate Scorbutic Cholics, and Pains of the Bowels.*

TAKE English barley, and having well washed it, boil it in a sufficient quantity of fresh spring-water, till it be just ready to burst: then pour off the clear upon the yellow part of the rinds of lemons, freshly cut off from the white part, and put them into a bottle, which being carefully stopped, the liquor is to be kept so for use, which is, that the patient make it his constant drink.

XXII. *To*

XXII. *To reduce flaggy Breasts to a good shape and consistence.*

TAKE green hemlock, well bruised and reduced to a kind of cataplasim or poultice, which is to be applied (the cold being first taken off) to the parts it is to work upon, and to be kept on, till it hath performed what was intended, shifting it once a day.

XXIII. *An easy, but useful Remedy for a fresh Bruise or Contusion.*

TAKE fresh butter and parsley, of each a sufficient quantity, and having chopped the herb, mix it very well with the butter to the consistence of a cataplasim, which is to be applied warm, to the newly bruised part.

XXIV. *For Coagulated Blood, or a Bruise.*

TAKE black soft soap, and, with a sufficient quantity of soft crums of white-bread very well mixed with it, make a paste, which is to be laid on the part with a linnen rag, and kept bound upon it for some hours, that it may have time to resolve the congealed blood, and bring the contused part from a livid to a red colour, which will much hasten and facilitate the restoring it to its former state.

XXV. *To stanch Blood falling from the Nose, by a Simple held in one's Hand.*

LET the patient hold knot-grass and Solomon's-seal in his hand, till it grow warm there, or longer, if need be.

XXVI. *An excellent Remedy to stanch Blood in any part of the Body.*

TAKE plantain-water two ounces, barley-cinnamon-water, six drams, spirit of vinegar one ounce, dragons-blood half a dram, syrup of myrtles five drams; mix and make a julep, of which let the patient take three spoonfuls every hour.

XXVII. *The Styptick Water for stopping of Blood in any part of the Body.*

TAKE one pound of excellent quick-lime, and put it into a clear earthen-pot, pour upon it five or six pounds of fountain water, cover the pot close, and let it lie to infuse about an hour without touching it, then after stir it with a stick for a little time; then let it lie as before for twenty-four hours, sometimes stirring it; in the end you shall let it settle to a sediment; the water being very clear above, pour it off by inclination without stirring: take of this water one pound, which being put into a vial, you shall add to it a dram and a half of sublimate finely powdered; then shake very well all together, so that the powder may dissolve, and be of an orange colour, as more reddish than yellow, and in the end clear and limpid, because the red powder will precipitate to the bottom. Your water being clarified, you must separate the water from the grounds into another vessel, without troubling the sediments; and to the water you shall add one dram of oil of vitriol, and an ounce of *saccarum Saturni*. Shake all together, that they may mix the better; afterwards let all settle, and pour off the clear water, and keep it for your use.

XXVIII. *A choice Medicine to resolve Extravasated Blood.*

GRATE or rasp the root of burdock, and spreading the powder upon a linnen cloth, bind it round the part affected, renewing it twice a day.

XXIX. *To*

XXIX. *To make an excellent Styptick for Stopping of Blood.*

TAKE Hungarian vitriol, allom, of each half a pound, phlegm of vitriol ten pounds: boil to a dissolution of the vitriol and allom; being cold, filter it through brown paper, and, if any crystals shoot, separate the liquor from them, adding to each pound one ounce of oil of vitriol. Dip cloths into this liquor, and apply them to the part affected.

XXX. *An often tried Styptick to stanch Blood, especially in Wounds.*

TAKE colcothar, as it comes out of the retort, and having powdered it, roll tents of lint in it, and apply them to the orifices of the greater vessels, and employ other usual means to impress the vessel upon the tent, and to fill the cavity of the wound, partly with colcothar too.

XXXI. *A very often experienced Remedy for Burns.*

TAKE two parts of oil of walnuts, and one of honey, mix them well together over a gentle fire, and, when they are thoroughly incorporated, dip a feather in the mixture, and anoint therewith the part affected so, as the ointment may touch it immediately, and then strew on it some powder of ceterach, or spleen-wort, and keep the part quiet, and defend it from the air.

XXXII. *An easy Medicine, and common enough, but useful against Burns.*

TAKE onions, and beat them into a soft mass, and apply them as speedily as you can to the part affected, and keep them on it, till they begin to grow dryish, and then, if need be, shift them, and apply fresh ones.

XXXIII. *For a recent Burn.*

TAKE onions a sufficient quantity, and beat them very well with common salt finely powdered into a mass, that may be applied as a cataplasm (the cold being first taken off) to the part affected; and renewing it, if need be, till the impression of the fire be taken out.

XXXIV. *An excellent Ointment for Burns and Scaldings.*

TAKE of the inner rhind of elder-tree, and of fresh sheep's-dung, without any adhering straws or foulness, of each one handful, and with fresh butter or oil, make thereof an ointment, to be applied as is usual in such distempers.

XXXV. *An easy and approved Remedy for Burns, especially recent ones.*

TAKE a sufficient quantity of adder's-tongue, and boil it softly in linseed oil, till the liquor be strongly impregnated with the herb; then strain it, and keep it stopp'd for use.

XXXVI. *An excellent Ointment for Burns and Scaldings.*

TAKE of *saccarum Saturni* half a dram, of the sharpest vinegar four ounces; make a solution of the former in the latter, and add to this solution drop by drop, (often stirring or shaking them together) as much oil of elder, as will serve to reduce the mixture into the form of a nutritum or ointment.

XXXVII. *A*

XXXVII. *A slow but innocent way of making Blisters without Cantharides.*

TAKE crow's-foot, and putting to a handful of it about half a spoonful of mustard, beat them very well together to the consistence of a poultice; put this to the thickness of one's little finger into a cover of a box cut shallow, and of about the breadth of the palm of one's hand (though this cover be less necessary than convenient,) and cutting a hole of the wideness of the box in a plaister of diapalma, or the like, to make it stick, you must apply it to the part, and let it lie on twelve or twenty-four hours, because it works as well more slowly, than cantharides, as more safely and innocently.

XXXVIII. *A good Medicine to raise Blisters.*

TAKE cantharides reduced into powder, and upon half an ounce of this put two or three ounces of good spirit of wine; let them lie together four or five days, that the spirit may acquire a good tincture; then filter it, and dip into it a piece of linnen cloth 6, 7, or 8 times double, and of the figure and largeness, that you desire. This cloth being thoroughly wetted and covered with a melilot plaister, or one of diachylum, or some other, that will stick, to keep it on, must be applied to the part. At the end of five or six hours you may take off your plaister and the linnen cloth, and find your work done.

XXXIX. *To raise a Blister without Cantharides.*

THE seed of *clermatis peregrina* being bound hard upon any part, will in an hour, or at most two, have an operation like that of another vesicatory, as far as its contact reaches.

XL. *An useful Medicine for Costiveness.*

TAKE virgin-honey a sufficient quantity, and mix exactly with it as much finely powdered *cremor tartari*, as will suffice to bring it to the consistence of a somewhat soft electuary, of which the patient may take upon the point of a knife the bigness of an almond (more or less) as upon trial you shall see cause.

XLI. *For a Cancer in the Breast.*

TAKE of the warts, that grow on the hinder legs of a (stone) horse, dry them gently till you can reduce them to a powder, of which you may give half a dram for a dose in any convenient vehicle.

XLII. *A potent Medicine for Contusions and divers other Affections.*

Take alcohol of wine, and dissolve in it as much pure camphire, as you easily can, and keep it very close stopt, till you have occasion to use it. Then moisten thoroughly with it some thin pieces of linnen or flannel, and apply them lukewarm: and likewise you may, with a rag dipt in it, apply it to the eye-lids, having a care, that none of it get into the eye itself, since there it would cause great smart. It may also be very usefully applied to burns, and yet more to contusions.

XLIII. *A tried Medicine for Chilblains.*

TAKE pretty thick parings freshly cut off from turnips, and hold them to the fire, till they be very crisp; then apply them to the unbroken tumours or blisters, as hot as the patient can endure it, and keep them on a competent time, and put on

new if need require. They will cause the peccant matter to transpire, or otherwise waste, without breaking the blisters.

XLIV. *To make a very nourishing Aliment, that hath recovered divers in Consumptions.*

TAKE eight or ten craw fishes, (or, if they be not of the largest size, a dozen) boil them (after the blackest gut or string is taken out) in barley-water, till they become very red; then take them out, and beat them long, shells and all, in a marble or glass-mortar, to a soft mash, and in a press strongly squeeze out the juice; which may be given either alone, or mixt with about an equal part of chicken-broth, or some such convenient alimential liquor.

XLV. *A vulgar, but often approved remedy for a Cold, especially that affects the Breast.*

TAKE a sheet, or half a sheet *pro re nata*, of brown paper, of as even a texture as you can get, and anoint it over evenly and very well with the eldest tallow, or candle-grease you can procure, so that the paper may be thoroughly penetrated by it: then cover it thinly with nutmeg, as you were to rub the spice upon a toast, and clap it warm to the pit of the stomach, that it may reach a good way, both above it and beneath it.

XLVI. *An experienced Medicine for Coughs.*

Boil good turnips in water, and having expressed the juice, mix it with as much finely powdered sugar-candy as will bring it into a kind of syrup, of which let the patient swallow a little as slowly as he can from time to time.

XLVII. *A good Medicine for Asthmatic Coughs.*

TAKE two ounces of oil of sweet almonds freshly drawn, and put them upon one drachm of flour of brimstone, keep them for a fortnight in digestion in a moderate heat, and then decant off the oil, or pass it through a clean linen rag to keep back the: brimstone of this liquor give a spoonful or two at a time.

XLVIII. *An easy Medicine, which cured not long since a Gentlewoman, that had taken much Physic for a Consumptive Cough.*

TAKE eight, ten, or twelve chosen raisins of the sun, and having slit them open, take out the little kernels, and stuff the raisins with the tops or small tender leaves, of rue; and let the patient take them, either as they are, or in the form of a bolus, or the like, pretty early in the morning, fasting after them two or three hours at least, if he cannot conveniently fast until noon.

XLIX. *A potent Medicine (for those, that can bear it) to ripen Coughs, and hasten the Expectoration of Phlegm.*

TAKE onions, cut them into slices, and fry them with fresh butter, as if you were to eat them; then take them out of the frying-pan, and boil them with new milk until it be well impregnated with them, and they be made tender: of this mixture let the patient take a moderate quantity from time to time.

L. *An excellent Remedy for a Cough.*

TAKE of virgin-honey two ounces, of red-roses warily dried and finely powdered half an ounce, of choice sulphur very well sifted two drams, of good benjamin reduced to fine powder one drachm; beat and mix all these very well; of this let the patient take the mixture from time to time.

LI. *A Plaister to prevent Corns.*

TAKE yellow bees-wax four ounces, verdigrease exactly powdered and sifted one ounce, the caput mortuum of the skull of a man one dram. Incorporate them well with boiling a little, and make thereof a plaister according to art.

LII. *An effectual Plaister for softening and loosening Corns.*

SPREAD a plaister of gum ammoniacum, (not too thick) without being dissolved in vinegar, and applying it to the part affected, let it lie on, until it have sufficiently done the designed work of emolition.

LIII. *A powerful (but smart) Remedy for Corns.*

EVAPORATE the strongly expressed juice of radishes to the consistence of a soft plaister, to be applied to the part affected, and shifted as often as it grows dry. N. B. It will sometimes smart for a while at first, but afterwards it will do its work.

LIV. *A good Remedy for Corns of the Feet.*

TAKE the yeast of beer (not ale) and spreading it upon a linen rag, or other cloth, apply it to the part affected, renewing it once a day.

LV. *An excellent Remedy, that has cured many Children of Convulsive Fits.*

TAKE two or three drops of (chymical) oil of rosemary, and put it into half an ounce of sack in an ounce bottle; stop the vial, and let it be well shaken to make a whitish mixture of the liquors just before you give it. Or else in a half-pint bottle or vial, put four ounces of sack, or some appropriated liquor, and drop into it forty drops of the forementioned oil; and whenever you are to give the medicine, shake the vial well stopt, and presently give of the whitish mixture a child's little spoonful.

LVI. *A successful Medicine for Convulsive Fits and Hysterical Vapours (as they call them) or Fits of the Mother.*

TAKE the liver of a hare (if it hath been hunted, it may be the better) and hang it up in a dry place, till it be somewhat friable, having a care that it putrify not; of this reduced to powder, let the patient take two or three scruples at a time in any convenient vehicle.

LVII. *An excellent Medicine for dry or convulsive Asthmas, and also for Costiveness.*

GIVE at bed-time eight or ten grains of choice saffron, pulverized grossly in a little syrump or conserve, as of violets, &c. to embody it with.

LVIII. *An excellent Mixture for Fits of the Cholick, and some kinds of Convulsions.*

TAKE one ounce of flowers of sulphur, and as much sugar-candy; grind them very well together in a glass or stone mortar, and upon this quantity drop thirty drops of oil of carraway-seeds, as much of orange, and as much of the oil of anniseeds: incorporate these well, and of the mixture give about twenty or thirty grains for a dose.

LIX. *An incomparable Medicine for the Cholick.*

THE yellow peel of oranges being reduced to powder, give from half a drachm to two scruples of it in any convenient vehicle.

LX. *To make good Purging Drink for the Cholick.*

TAKE two ounces of rhubarb, four ounces of gentian, and a quart of good anniseed-water; let the roots infuse a long time in it, and give the patient about two spoonfuls at a time, as often as need requires.

LXI. *An almost specific Remedy for a fit of the Cholick.*

TAKE about half a drachm of expressed oil of nutmegs, (usually sold in the shops for East-indian oil of mace) dissolve this in some spoonfuls of good wine, which the patient is to take as hot as conveniently he can.

LXII. *An uncommon, but tried Remedy for Cholicks (without much Matter) and good in Fits of the Mother.*

TAKE good ginger dry, and instead of powdering it, cut it into as thin slices as you easily can: with these fill a tobacco-pipe, and take the smoak as you would that of tobacco. Do this twice, thrice, or four times a day, but especially at bedtime, and in the morning.

LXIII. *An excellent Medicine for Convulsive Cholicks.*

TAKE of the volatile salt of pidgeon's-dung two or three grains, or somewhat more; (not exceeding five or six in all) mix these with a scruple or half a drachm of the same dung crude, but well and slowly dried, and finely powdered. Give this mixture for one dose in some spoonfuls of any convenient vehicle.

LXIV. *For the Cholick, or Pains in the Sides.*

TAKE two balls of fresh horse-dung, and infuse them for twelve hours (if haste require, three or four may serve the turn) in good white-wine, in a close vessel; then strain the liquor, and let the patient take five or six ounces of it at a time.

LXV. *For the Cholick.*

BOIL about one ounce of the seeds of the black stinging nettles in about a quart or more of good claret-wine; then strain the decoction, and give of it a wine-glass full at a time, two or three times a day, or as often as need requires.

LXVI. *An excellent Medicine for the Cholick.*

TAKE of Dr. Stephens's water half a pint, plague-water half a pint, juniper-berry-water half a pint, powder of rhubarb two ounces; mingle these together,
shake

shake the bottle when you take any of it, and take about four spoonfuls at a time.

LXVII. *For the Cramp.*

TAKE the leaves of rosemary, chop them very small, and sew them so in fine linen or farfenet, as to make a kind of garter of them to be tied about the patient's bare leg.

LXVIII. *To take off the Pain of the Cramp.*

TAKE of the ointment of populeon two parts, oil of spikes one part; mix them, and with the mixture anoint well or chafe the part affected.

D.

LXIX. *A Remedy, by which an Hydropical Merchant was cured.*

GIVE about half a drachm or two scruples for a dose of yellow transparent amber, twice or thrice a day in any convenient vehicle.

LXX. *An experienced Medicine for a Dysentery, or Bloody-Flux.*

GIVE about three ounces of the juice of ground-ivy, mixt with one ounce of the juice of plantane, once or twice a day.

LXXI. *For to stop a Dysentery, or Bloody-Flux.*

USE the powder of *crepitus lupi*, or fufs-balls, made up with some conserve of roses, or other convenient additament, into pills. Of this mixture give *in dysenteria*, as much at a time, as contains from about a scruple, to about half a drachm of the powder.

LXXII. *An easy, but very often tried Digestive, to be used instead of Basilicum.*

TAKE two ounces of good Venice-turpentine, and incorporate very well with it the yolks of two fresh eggs, and then add to it (at discretion) a little spirit of wine; with this dress the part morning and evening, laying it on thicker, if the part be near some nerve or other drier part, and less thick, if it be fleshy or moist.

LXXIII. *A good Medicine for Incontinency of Urine, and the Beginning a Diabetes.*

CUT off the necks of well-blown sheep's-bladders; of the remaining membranes put up pretty store one over another into a covered pot, where being dried gently, and yet sufficiently, in a baker's oven, take them out and pulverize them well. The dose is as much as will lie upon a large groat, or small six-pence.

LXXIV. *For a Diarrhœa, Looseness, or Flux of the Belly.*

MIX up fifteen grains, or if the distemper be but slight, ten grains, of powdered rhubarb, with half a drachm of diascordium, and let the patient take it either going to bed, or early in the morning after his first sleep.

E.

LXXV. *For a Contusion in the Eye.*

TAKE the crumb of white-bread, and diligently incorporate with black soft soap as much of it, as will make a somewhat soft paste; and then with your thumbs make a little cake (as it were) of it, and apply to the bruised part, the eye being first shut, and blind it so, that it may lie on for some hours, or a day, if need be. But this ought to be used with caution.

LXXVI. *An excellent Medicine for clammy Humours of the Eyes.*

TAKE new milk, and let it stand, until it hath got a little cream upon it: then let the patient, when he is in bed, take up with his finger a little of the cream (and not of milk) and shutting his eye-lids, besmear his eyes with it, having a care, that very little or none get into his eyes, because it would make them smart; let the cream lie on, until the next morning, and in case the patient chance to wake in the night, he may, if he finds cause, lay on a little more, and wash all off in the morning.

LXXVII. *A somewhat sharp, but often tried Medicine, to take off the Pearl on the Eye.*

TAKE of the juice of celandine, and mix with it about an equal part of pure honey; and of this mixture employ a drop, or at most two, at a time, letting it fall upon the part affected morning and evening.

LXXVIII. *An easy Remedy for a recently Blood-Shot Eye.*

TAKE a rotten apple, and as many tops of wormwood, as being well beaten together with it, will make a mass of the consistence of a cataplasm; warm this a little, and put a sufficient quantity of it into a thin and clean linen rag, and let the patient keep it upon the part affected all night, the next morning wash it off with some red rose-water, or the like liquor.

LXXIX. *To make a choice Ophthalmic Water to preserve the Eyes and Sight.*

TAKE of the distilled water of rue, celandine and vervain, of each one ounce; mix them, and infuse in them two drams of *crocus metallorum* exquisitely ground, for a week or ten days; then very carefully filter the infusion, that none of the atoms of powder pass thorough the liquor. Of this let fall into the eye a drop or two, morning and evening, having a care not to shake the glass, when you employ the liquor, lest some unheeded dust may have escaped the filter, and be raised.

LXXX. *For a slight Ophthalmia, or Blood-Shot Eye.*

SHAKE half a drachm of diligently prepared tutty into an ounce of red rose-water, and drop it often into the eye.

LXXXI. *An experienced Eye Water for an Inflammation and Tumour of the Eye.*

TAKE of prepared tutty half an ounce, the water of white roses and of frog's spawn, and also of the best canary wine (not distilled) of each two ounces, of aqua mirabilis half an ounce. Mix these well, and drop a very little at a time into the patient's eyes.

LXXXII.

LXXXII. *An odd and often tried Medicine for an Erysipelas.*

TAKE the blood of a hunted hare whilst it is yet warm, and drench thoroughly in it clean linen rags, which are to be dried in the wind or free air, and then kept in a dry place for use: lay a good piece of linen thus stained upon the part affected, and either by binding it on, or covering it with some silken or other cloth, whose edges have some sticking plaister, keep it from falling off, and renew it from day to day, if there be need. *N. B.* If it be grown too stiff with long keeping, you may soften it with a little sprinkling of fair water.

LXXXIII. *An experienced Water for sharp and slimy humours in the Eyes and Eye lids.*

TAKE of prepared tutty half an ounce, prepared coral and pearl of each half a scruple, *trochisci-albi ras.* five or six grains, red rose-water, and succory-water, of each an ounce and a half; mix them well, and if you will have the medicine stronger, you must put three or four grains of aloes into it.

LXXXIV. *A choice Remedy for an Ophthalmia, or Blood-Shot Eyes.*

TAKE of the juice of housleek two parts, daisies and ground-ivy, of each one part; mix these juices together, and to about two spoonfuls of the mixture, put five or six drops of clarified honey: let the juices depurate themselves by residence, and then in some small silver vessel clarify them, and of this mixture let fall a drop or two into the eye three or four times a day. *N. B.* But if the inflammation be not so great, but there is more need of absterfion, use more of the juice of ground-ivy, and less of that of housleek.

LXXXV. *For a light Stroke or Contusion of the Eye.*

TAKE two ounces of betony-water, and three drops of clarified honey, mix them well together, and drop them into the eye three or four times a day; the composition must be made fresh every second and third day.

LXXXVI. *A potent, but smarting Medicine for things growing on the Eye.*

TAKE white paper, and let it flame away upon a clean pewter platter, till there remain so much oil behind, as you think you shall need; blow off the cinders of the papers, and with a little of your spittle mixt by your finger with the oil, make up a kind of ointment; which, being taken up with a feather, is to be applied once or twice a day, as need shall require (and as the patient can well bear) to the affected eye; which course is to be continued, till the cure be compleated.

LXXXVII. *For Hurts, that make the Solution of Continuity in the Eye.*

TAKE two ounces of celandine-water, and put to it two, three or four drops of good clarified honey, enough to give the water a faint taste: with this dress the eye at least twice (if not thrice) a day. But the mixture must be made fresh once in two or three days, or else it will grow fourish.

LXXXVIII. *An excellent and very often tried Eye-Water, especially for outward Affections of the Eye.*

TAKE of plantane-leaves 4 ounces, and of strawberry-leaves as much; digest these for 24 hours in a pound of good white-wine; then distill them to dryness in a
glafs.

glafs head and body in a *balneo Mariæ*. The liquor that is thus obtained, put into a very clean brafs (not copper) vefſel, and let it ſtand there ſome hours, till it have acquired a manifeſt, but not a very deep blue tincture; and then put to it (when poured on) an equal weight of white-roſe-water diſtilled after the common way: ſhake theſe together, and let fall one drop into the internal corner of the eye, the patient ſtooping backward, and ſhutting his eye-lids for a minute or two, that the water may diſperſe on the eye, and that the quickneſs of the liquor, which may make him weep, may the leſs prejudice him.

LXXXIX. *To make a uſeful Medicine for Pain or Itching in the Eye-lids, or on that Account in the Eyes.*

TAKE half a ſpoonful of French barley (after the firſt water it was put into over the fire is caſt away) and boil it ſoftly for a little while in a pint of ſpring-water, ſeaſonably putting to it a good pugil of dried damaſk roſe-leaves. (*N. B.*) Sometimes you may add, if you pleaſe, a few red roſe-leaves, or melliot-flowers, or both.) With this liquor foment the part with a ſoft ſponge for a pretty while, in the morning, and at night, having a care, that it be applied pretty hot, or at leaſt warm.

XC. *To make an excellent Eye-water, for Redneſs and Light Films, &c. in the Eye.*

MAKE ſome lime-water, by pouring a gallon of ſcalding hot water upon a pound or ſomewhat more of quick lime; ſtir them together, and after ſome hours, decant warily that, which is clear. And to a pound of this water put half an ounce (and no more) of choice verdigreaf pulverized; and in a very moderate heat extract a tincture of a fine, but ſomewhat dilute, ſapphirine colour (but it ought not to be too deep.) Decant this very warily, and let a drop or two of it at a time fall into the eye, as often as need requires.

XCI. *An excellent Remedy to ſtop a violent Deſluxion on the Eye.*

TAKE red ſage and rue, of each one handful, a ſpoonful of fine wheat-flower, and the white of a new-laid-egg beaten to water; mix theſe very well, and ſpread them upon very thin leather or black ſilk, and apply it to the temples: it is to be about the bigneſs of a ſilver crown at leaſt.

XCII. *An excellent Remedy for red Eyes, made ſuch by a Deſluxion of a hot or ſharp Humour.*

TAKE the tops of roſemary about one drachm, and beat them up with one or two ounces of rotten pearmainſ or pippins, or, if thoſe cannot be had, with the like weight of the ſoft part of the ſame apples, that are ſound: and when by exquisite beating, you have reduced theſe things to a cataplaſm, apply them (the cold being firſt taken off) to the part affected, binding it thereupon, and letting it lie all night.

XCIII. *An Eye-water.*

TAKE houſe-fnails, and beat them in their ſhells, and gratify them with about an equal quantity of juice of celandine; and draw off the water in a cold or pewter ſtill (ſuch as is uſed for roſe-water) and keep the liquor, that will come over, cloſe ſtopt for your uſe.

XCIV.

XCIV. *The Lady Fitz-Harding's Eye-water, which lately cured an almost blind Person, whose Eyes looked like Glafs.*

TAKE three spoonfuls of white rose-water, as much eye-bright-water, and as much sifted white sugar-candy, as will lie on a three-pence, and the same quantity of fine aloes sifted and put to the water, and shaken together, and drop a few drops every night going to bed.

XCv. *A Pericarpium, or Wrist-plaister, that oftentimes frees the Patients from flying Clouds in the Eyes, and sometimes lesser Specks, especially if recent.*

TAKE of rue, camomile, hemlock, each half a handful, of bay-salt two spoonfuls, one or two ounces of leaven; incorporate these well together, and make thereof *pericarpia*, to be applied to the patient's wrists, and kept on, till growing dry, they become troublesome.

XCvi. *An excellent Medicine for hot Defluxions on the Eyes.*

TAKE of prepared tutty half an ounce, white rose-water, and frogs spawn-water, carefully drawn in very good canary-wine, of each two ounces, of *aqua-mirabilis* half an ounce; mix these well together, and let fall two or three drops into the patient's eye, especially at bed-time.

XCvii. *An easy but useful Eye-water to keep the Eye cool and moderately dry.*

TAKE two ounces of succory-water, half a drachm of prepared tutty, shake them well, and keep them together for use.

XCviii. *An often tried Pericarpium, or Wrist-plaister for Defluxions and Fumes in the Eyes.*

TAKE rue, camomile, hemlock, wormwood, of each half a handful, bay-salt pulverized about two spoonfuls, four dough about an ounce; mix all these together very diligently, moistening them from time to time with elder vinegar to a consistence fit for *pericarpia*, one of which is to be applied to the wrist of that side, on which the part affected is, and to be renewed, if there be occasion.

XCix. *For a Phylectena, or little Tumour in the carneous Tunicles of the Eyes.*

TAKE the decoction of mucilages, that is proper for phylectenas, and dress the eye from time to time to ripen the tumor: then open it with a lancet, and squeeze out all the matter; and lastly, cleanse and heal the part with honey. *N. B.* But when the tumor is beginning, or not great, you may, in want of the decoction of mucilages, dress the eye with the mixture of equal parts of the water of melilot, camomile, and betony.

C. *A Plaister to strengthen the Eyes, and stop Defluxions on them.*

TAKE of frankincense two ounces, *olibanum* and mastick, each half a drachm; mix these well, and reduce them into fine powder, of which a convenient quantity is to be melted and spread upon black ribbon, or some such thing, with a hot knife or spatula, and so presently applied to the temples.

CI. *An often experienced Medicine for little Strokes or Contusions in the Eye.*

TAKE betony-water three ounces, and five drops of clarified honey; mix them, and drop a little of the mixture from time to time into the patient's eye. *N. B.* Take succory-water, crumbs of white-bread, a little saffron, and sometimes a little honey, for sharp humours in the eye-lids, and burns or small specks (of the eye;) four grains of roman vitriol to four ounces of water, of either rose-water, succory-water, or fennel-water, &c.

CII. *A good Electuary to strengthen the Sight.*

TAKE conserve of borage and betony, of each an ounce and a half, Venice-treacle two drachms, *species Dionysi, dairrhodon abbatis, diatryon santalon*, of each half a drachm, tartar vitriolate a scruple, diacorallion a drachm and a half, oil of fennel seven drops, syrup of violets and coral, of each a sufficient quantity; mix and make an electuary.

CIII. *A choice Medicine for an Ophthalmia Sicca.*

TAKE of the leaves of fennel, hyssop, celandine, betony, and carduus, of each half a handful, or a whole handful; of linseeds, quince-seeds, fenugreek, and fleawort, of each half a drachm, of French barley one ounce: boil all these a little in two quarts of fair water, and half a pint of white-wine. Let the patient hold his head (well fitted with a napkin for the purpose) over the fumes for about a quarter of an hour.

CIV. *For a Film, or other such Thing, growing in the Eye.*

TAKE of crude roch-allom two parts, turmerick one part, and refined sugar three parts. Pulverize each of these separately, then mix them exactly, and warily blow it into the patient's eye from time to time, as need shall require.

CV. *To make an excellent, as well as famous Eye-water.*

TAKE celandine (the whole plant except the root) and having shred it, or chopt it a little, put it into a retort, and distil it in balneo. When all the liquor is come over, empty the vessel, and put in it as much as the fresh plant, and distil the liquor from it to make it more strong of the plant. Put this liquor once more upon new or fresh celandine, and distil in balneo as before; and keep this well-impregnated water close stoppt. It is to be outwardly used in the dose of two, or three, or four drops at a time.

CVI. *A Medicine for Hurts in the Eye.*

TAKE succory-water and crumbs of white-bread, enough to bring it almost to a consistence; then add a little saffron to tinge and quicken it, and sometimes also you may put to it a little honey, to make it more cleansing and healing. Apply it (if need be) with pledgets of flax to the part affected.

CVII. *A Remedy, that hath cured the Epilepsy.*

GIVE daily half a drachm at a time of choice and very finely powdered amber, in any convenient vehicle for about six weeks together.

CVIII. *Elixir Salutis.*

TAKE of the seeds of anise, sweet fennel, coriander and parsley, of each two ounces; of liquorish scraped, washed and bruised, and choice leaves of fenna, of each

each likewise two ounces; of raisins of the sun, rubbed clean and bruised, one pound; of elecampane-roots and guaiacum-wood, of each one ounce. Mix these ingredients, and pour on them two quarts of *aqua vitæ*, or English spirits (for brandy is too hot a liquor.) Let these infuse together forty-eight hours. Then put them all in a hair-bag, and press them strongly in an apothecary's press, and, if there be need, pass what is strained through an hippocras bag after the liquor is settled. Keep this in bottles well stoppt in a cool place, and give of it two or three spoonfuls at a time, in the morning fasting, and, if need require, at bed-time.

CIX. *An experienced Remedy for Convulsions and Epilepsies in Children.*

TAKE about half a drachm, or from one scruple to two, or somewhat more, of well-chosen and very finely powdered amber, native cinnabar ten grains; mix them, and of this, sweetened with some powdered sugar, or other fit thing, that may give it a relish, let the patient take twice a day (at least for most days) during six weeks, unless he fully recovers before that time: and, however, he is to take it for two or three days before each new and full moon, for some months successively.

F.

CX. *An excellent Drink in Fevers, even malignant.*

TAKE a quart of spring-water, and having given it a walm or two, put to it one ounce of harts-horn calcined to perfect whiteness, and when the mixture is cold, put to it three ounces of syrup made of the juice of lemons; shake this mixture; when you will use it, shake it well, and let the patient take of it a moderate draught several times in the day and night.

CXI. *An useful Drink in feverish Distempers.*

IN a pint and a half of clear posset-drink boil about one ounce of cleaned roots of dandelion, or pils-a-bed, cut or sliced very small, till near half a pint be wasted, and then strain it, and let the patient take half a pint, or the whole quantity, if he can, at a time.

CXII. *An excellent Remedy for dysenterical Fluxes.*

TAKE good Venice-turpentine, and with a very gentle heat evaporate so much of it, that when it is cold it may be but little short of coagulation. This yet soft, but not fluid substance, incorporate with fine sugar, enough to make it up into pills, whereof give in the morning fasting as many, as will amount from a scruple to half a drachm, or two scruples, or a whole drachm of turpentine, besides the sugar.

CXIII. *An uncommon, but experienced Remedy for dysenterical Fluxes.*

TAKE the bone of the thigh of a hanged man (perhaps another may serve, but this was still made use of) calcine it to whiteness, and having purged the patient with an antimonial medicine, give him one drachm of this white powder for one dose, in some good cordial, whether conserve or liquor.

CXIV. *For the Dysentery and Fluxes caused by sharp Humours.*

TAKE from half a drachm to one drachm of *mercurius dulcis*, and as much either of fine sugar or sugar-candy, and with some purgative or other, let the patient take it once a day, with care, that none of it remain in his mouth, or stick in his throat.

CXV. *An often tried Medicine for Fluxes of the Belly, though bloody ones.*

GIVE for a dose, in any convenient vehicle, as much powdered or grated pizzle of a hart or deer, as will lie upon an ordinary half-crown-piece.

CXVI. *An effectual Medicine for dysenterical and other Fluxes.*

TAKE of a hare the skin, liver, gall, and all the parts, except the muscles; and having dried them so far (and no further) as that they may be conveniently reduced to powder, give of this powder, from about two scruples to one drachm, in any convenient vehicle.

CXVII. *An experienced Remedy for sharp Fluxes of the Belly.*

TAKE a pint of new milk, and dissolve in it two ounces of loaf sugar, and at length about the bigness of a walnut of good mithridate; give this mixture moderately warm for a clyster, to be reiterated, if there be occasion.

CXVIII. *To stop Fluxes and Whites.*

FOR fluxes you may, in divers cases, give the patient from time to time a moderate quantity of a decoction of half an ounce of ising-glass, in about a pint of new milk.

CXIX. *An easy Medicine for Fluxes, especially those caused by sharp Humours.*

INSTEAD of butter take well-conditioned olive-oil, and thoroughly drench therewith a good toast, and let the patient eat it.

CXX. *For a Bloody-flux.*

TAKE half an ounce of London-treacle, an ounce, or an ounce and a half of conserve of red-roses; mix them together with some syrup of clove-gilly-flowers, or syrup of citrons, and keep them thus mixed in a pot covered for your use. Take of this about the quantity of a walnut at night, and in the morning, for two days, fasting two hours before and after; intermit then a day, and take it again in the like manner.

CXXI. *A tried Medicine for the falling down of the Fundament.*

TAKE some ginger, and having carelessly sliced it, put it in a little pan, heat it by clear and well-kindled coals, and let the patient receive the fume of it, cast on by little, in a kind of close-stool, or some equivalent seat, where the lower part of the body may be well covered for about half a quarter of an hour at a time.

G.

CXXII. *A Medicine for a light incipient Gangrene.*

AFTER having lightly scarified the part affected, apply, as hot as the patient can well bear it, a cataplasim made of strong brandy, and the pith or crum of white-bread, shifting it three or four times a day, or somewhat oftener, if need be.

[N. B.] Some use turnips boiled, and made unctuous with a little fresh hogs-lard, to resolve the hard tumors of women's breasts.

CXXIII. A

CXXIII. *A choice Anodyne Clyster.*

TAKE marsh-mallow-roots half an ounce, leaves of the same, mallows, mullein, of each one handful, camomile-flowers, two pugils: boil them in a sufficient quantity of water till ten ounces, yolks of two eggs, and oil of camomile an ounce and a half: mix and make a clyster for easing pain.

CXXIV. *A slight, but often tried Medicine for the Gripping of the Guts.*

TAKE about a quarter of a pint of brandy, and having made a toast of bread (not too fine and white) throw it very hot into the liquor, and as soon as it is thoroughly drenched, let the patient take it out, and eat it hot; and this may be repeated, if there be need, two or three times a day.

CXXV. *An often tried Remedy for the Gripes in little Children.*

TAKE of oil of nutmegs, and of worm-wood, of each a little quantity, mingle them well, and with the mixture a little warmed, anoint the patient's navel, and the pit of the stomach.

CXXVI. *To make an excellent Gargle.*

TAKE six ounces of scabious-water, one spoonful of mustard, one spoonful of honey, and one spoonful of vinegar; grind all these very well together in a marble or glass mortar, till you have reduced them to a liquid mixture, which is to be used as a gargle.

CXXVII. *A choice Gargle for a sore Throat.*

To four ounces of plantane-water add three or four spoonfuls of red rose-water, and mix very well with these the white of an egg beaten to a glair or water: sweeten this mixture with a spoonful of white sugar-candy, or, in want of that, as much very fine loaf-sugar. Let the patient gargle this as often as need requires.

CXXVIII. *An experienced Medicine for a Gonorrhœa.*

TAKE two ounces of ripe laurel-berries, and infuse them for a day in a quart of good white-wine: of this let the patient drink about two or three spoonfuls twice a day for a pretty while together; only once in three days (or thereabouts) intermitting, that he may take some gentle purging medicine.

CXXIX. *For a Gonorrhœa.*

TAKE choice mastie a sufficient quantity, and having very finely beaten and seached it, take about half an ounce of it at a time in the yolk of a new-laid egg, washing it down, if it be thought needful, in any convenient liquor.

CXXX. *An excellent Remedy to take off the Pains of the Gout.*

TAKE minium or red-lead ground fine, half a pound, oil of earth-worms one pound, or a sufficient quantity: boil them to the consistency of a hard or solid emplaster, without burning: afterwards add of camphire two ounces, dissolved in oil of earth-worms, so much as may make an emplaster of a just consistency.

CXXXI. *An excellent Ointment in the Gout.*

TAKE Barbadoes tar and palm oil, of each a like quantity; melt them together in no more fire than is needful to make them incorporate well; with this mixture warm, the part is to be anointed, and warily chafed.

CXXXII. *A slight, but effectual Medicine to appease gouty Pains.*

TAKE linseed well conditioned, and, with a little water, beat them in a marble or glass mortar, rubbing them very well, that the medullary part may be separated in some measure from the husk, and may make the water considerably white. In this liquor dip clean rags, and when they are thoroughly wetted, apply them somewhat warm to the part affected, shifting them, if need be, once in an hour, or at most in two.

CXXXIII. *A speedy Remedy to take off arthritic or gouty Pains.*

TAKE good spirit of *sal armoniac*, and with a feather dipt in it moisten gently all the part, or parts affected.

CXXXIV. *A Medicine that almost presently appeases the Pains of the Gout.*

TAKE of black soap four ounces, choice wood-foot finely sifted about a drachm and half, and add to these about half the yolk of an egg: incorporate them diligently together, and spreading the mixture somewhat thin, apply it (the cold being first taken off) by way of cataplasm to the part affected.

CXXXV. *A homely, but often tried Medicine to appease the Pains of scorbutical running Gouts.*

TAKE earth-worms cleansed, and having filled an earthen pot with them, and luted on a cover very well, set it into an oven with a batch of bread, and let it stand there, till the oven be cold. Then take out the pot, and having removed the cover, you will find the matter turned into a gross liquor ill-scented. Strain this with expression, and keep it stopped for use, which is, to rub therewith the part affected with a warm hand once or twice a day. [N. B.] If the smell be offensive, you may put to it a few drops of oil of *rhodium*, or some other odoriferous one, to correct it.

CXXXVI. *An excellent Remedy for the Gonorrhœa.*

TAKE of choice amber and of mastich, both reduced to very fine powder, and very well mixed, equal parts, and of this mixture give half a dram at a time in a proper vehicle, or in a draught of chocolate; continue this for three weeks or a month, if need require, purging the day before you begin to take it, and once every week afterwards, especially when you leave off the use of the powder.

CXXXVII. *To appease the Pains of the Gout, and by degrees lessen the Fits.*

TAKE one part of *sal armoniac*, and three parts of spirit of wine, neither of them too well rectified: shake them together, (and, if you please, digest them a while) and having dipt old, but clean linen rags in the mixture, apply them to the part affected, shifting them now and then, as need shall require.

CXXXVIII. *To*

CXXXVIII. *To make an excellent Cephalic, or Head-powder, good also for the Eyes.*

TAKE the leaves of flowers of betony, marjoram and damask roses; also the flowers of sage and rosemary, all at discretion. To these add the powder of *lignum aloes*, and some seeds of *nigella Romana*: reduce all these to powder, to be used as a hair-powder, when the patient goes to bed.

CXXXIX. *An useful Drink to be frequently employed to correct sharp Humours.*

TAKE two ounces of choice barley (English or French) well washed from its dust and forders: boil this in a quart or more of spring-water till the grains begin to burst; then strain the decoction through a clean cloth, and let the patient use it at meals and other times for his ordinary drink.

CXL. *An experienced Medicine for Dulness of Hearing, and Hysterical Affections.*

THE juice of red onions is excellent for diseases of the ears, and for deafness in its beginning. [N. B.] Betony-roots also wonderfully prevail against all affections of the womb.

CXLI. *An experienced Medicine for the Pains of the Hemorrhoids.*

TAKE the sole of an old shoe, worn by some man that walks much; cut it in pieces, and burn it, not to white or grey ashes, but to a fryable and tender coal; reduce this to impalpable powder, and then with a sufficient quantity of unsalted lard, make it into an unguent, wherewith the part affected is to be anointed from time to time.

CXLII. *For the Hemorrhoids.*

MAKE a suppository of hogs-lard or bacon, or instead of that employ goose-grease made up in the same form.

CXLIII. *For the Hemorrhoids.*

IN the yoke of an egg, or a little of some convenient syrup or conserve, give from half a drachm, or two scruples, or one drachm, or somewhat more of flower of brimstone, once, or if the case be urgent, twice a day. The powder may be also given in milk to those, that like it better than sweet vehicles.

CXLIV. *A choice internal Remedy for Painful Hemorrhoids.*

TAKE about two scruples of choice sulphur *vive*, and mix it with a little sugar to make it relish, and give that dose once, or at most twice a day.

CXLV. *A very choice Medicine for the Pain and Tumors of the Hemorrhoids.*

TAKE fresh leeks (the whole plant) shred them small, and fry them well with fresh butter, till they be fit to be brought to the consistence of a cataplasm or poultice, that is to be applied very warm to the part affected, and to be renewed from time to time, as need shall require.

CXLVI. *An useful Medicine for the Pain of the Hemorrhoids.*

MAKE up flower of brimstone, and an equal weight, or a double, of fine sugar, with a solution of gum dragon, into tablets, that may weigh about a drachm apiece;
of

of those that contain the most sulphur, you may give one twice a day, but of the other sort much oftener, if need require.

CXLVII. *A choice Remedy for the Pain of the Hæmorrhoids.*

TAKE *album Græcum*, or white dogs-turd, reduced to an impalpable powder, mix it up with a sufficient quantity of goose-grease, and by grinding it well in a leaden mortar, reduce it to a black ointment, to be applied moderately warm to the part affected.

CXLVIII. *An experienced Remedy for unbroken Hæmorrhoids.*

TAKE calcined oyster-shells, and incorporate them with as much honey, as will make up the powder into an ointment, with which the part affected is to be tenderly anointed from time to time.

CXLIX. *For the Hæmorrhoids, a very successful tried Medicine.*

TAKE maiden-leeks (as some call those, that grow without having been transplanted) and casting away the green part, make of the bulbous part and a sufficient quantity of whole oatmeal a caudle, whereof let the patient eat plentifully.

CL. *A choice Drink for the Pain of the Hæmorrhoids.*

TAKE yarrow, and boil an handful of it in about a pint and a half of posset-drink, in a covered vessel, till it be strong of the plant; and of this decoction let the patient drink pretty plentifully from time to time.

CLI. *An excellent Remedy for the Pain of the Hæmorrhoids.*

TAKE of mastic, *olibanum*, aloes and myrrh, of each a like quantity; powder and mix them very well; then lay, or strew a sufficient quantity of this upon a pledget of lint or cotton, moistened thoroughly with spirit of wine over a few well-kindled coals, that the powder may melt, and be clapt hot to the pit of the stomach, or navel.

CLII. *A Medicine for the Pain of the Hæmorrhoids.*

TAKE a quart, or at least a pint, of new-milk, and boil it well for a while; and then taking it off the fire, presently put it into a close-stool in some open-mouthed vessel, and let the patient sit over the fume of it.

CLIII. *An excellent Medicine to appease the Pains of the Hæmorrhoids.*

TAKE two fresh eggs, and roast them pretty hard, then peel off the shells and mince them: to these add two pippins, the core being first taken out, that must be roasted to pap; mix these, and incorporate them very well with the eggs, reducing all to a kind of cataplasm, which is to be applied very warm, if not very hot, to the part affected.

CLIV. *A choice Medicine for Pains of the Hæmorrhoids.*

TAKE half a drachm of good flower of brimstone, and boil it a little in new-milk, and let the patient take fasting in the morning both the liquor and the powder, for many days successively. And, if need be, the like dose may be taken between four and five in the afternoon. Also one may make up the like quantity of flores, with

with a little fine sugar and gum tragacanth, into tablets or lozenges, to be taken instead of the powder and milk.

I.

CLV. *An experienced Liquor to cure the Itch in the Hands or Face, without Mercury or Sulphur.*

TAKE a handful of the roots of elecampane, and as much of sharp-pointed dock; shred them small, and boil them in two quarts of spring-water, to the consumption of a pint: then strain the liquor, and with it let the patient wash his hands, or other parts affected, once (or at most twice) a day.

CLVI. *An experienced magnetical Cure of the Yellow Jaundice.*

TAKE the gall-bladder of a sheep, and near the top, without emptying the liquor, make a hole, at which put in two or three drops of the patient's warm urine; then tye up the upper part of the bladder, and hang it in the free air, till it dry up, &c.

CLVII. *A homely, but not ineffectual Medicine for the Yellow Jaundice.*

GIVE about half a drachm of the white part of hen's dung, dried and mixed with a little sugar, in a few spoonfuls of white-wine.

CLVIII. *A Medicine almost specific for the Yellow Jaundice.*

TAKE of clean filings of steel a sufficient quantity, and, to make them grind the better, mix them with some loaf-sugar; grind them long with great exactness, for in that consists the chief secret of this medicine. Of this impalpable powder give about half a drachm for a dose (besides the sugar) and, if need be, give it twice or thrice a day in any convenient vehicle.

CLIX. *A specific Remedy for the Yellow Jaundice.*

TAKE one part of good saffron dried enough to be rubbed in a glass mortar into powder, and incorporate it well with four parts of choice turmeric. In the mean time take a handful of fresh sheeps-dung, and let it steep in about a quart of strong ale in a moderate heat, until the liquor be fully impregnated with the virtue of the dung. Then strain it lightly through a linen cloth; and into a pint of it, or as large a draught within the limit, as the patient can well take, give about half a drachm of the fore-mentioned mixt powder. This do in the morning fasting, and in the evening about bed-time, giving also another dose the morning after the first.

K.

CLX. *The great Medicine of a famous Empirick for the King's-Evil.*

GIVE, for a good while together, a pretty strong decoction of devil's bit.

CLXI. *To mitigate Pains in the Kidneys.*

TAKE oil of scorpions, and oil of bees-wax, of each a like quantity; mix them well, and with this mixture, moderately warm, anoint the pained kidney.

CLXII. *An effectual Remedy for Stoppage in the Kidneys.*

GIVE in any convenient liquor about a dozen grains of salt of amber for a dose.

L.

CLXIII. *A pleasant Medicine to appease Scorbatic Pains in the Limbs.*

TAKE liquid styrax; spread it thin upon flink, or some very fine kids-leather; and keep it upon the part affected till it dry up of itself, or till the patient has no more need of it.

CLXIV. *An Experienced, though simple Medicine for a Contracture produced by keeping of Limbs too long in an undue Posture.*

ANOINT well once or twice a day the part affected with dogs-grease, chaffing it in with a warm hand, and keeping the part warm afterwards.

M.

CLXV. *A good Medicine to increase Milk to those that give Suck.*

MAKE pottage with lentils (which many distinguish not from vetches) and let the patient use freely of it.

CLXVI. *Another Medicine to increase Milk in Nurses.*

TAKE earth-worms, wash them well, freeing them carefully from their excrements, and from all adhering earth and filth: then dry them so as they may not stink, and yet be pulverable. Of these, reduced to powder, give half a dram or two scruples for a dose, in wine, or any other proper vehicle.

CLXVII. *A Remedy, by which many Dogs bitten by a Mad-Dog, have been all of them preserved from running mad.*

TAKE three plants (*i. e.* roots and leaves) of that herb, which is called rose-plantane, or by some star-plantane; and having chopt it small with a convenient quantity of butter, let the bitten dog take it the first day; the second day give him five plants ordered as before, and the next day seven. *Lychnis Salamantica clus.*

CLXVIII. *A good Remedy for divers Affections of the Genus Nervosum, or nervous System.*

TAKE of the fresh roots of the male piony one ounce, of the seeds of the same plant two drams, and with a sufficient quantity of the syrup of piony, or some conserve of the like nature, beat them up into an electuary, (which is best done not long before you mean to make use of it) of which the patient may take the quantity of a small nutmeg, or more, if need be, twice a day, and, if occasion requires it, thrice.

P.

CLXIX. *Aloetic Pills, that do scarce at all occasion the Piles.*

TAKE of the Frankfort angelical pills, and give of them one scruple or half a dram, or two scruples, or more for a dose.

CLXX. *A Medicine for the Pain and Tumour of the Piles.*

TAKE the patient's own urine moderately warm, and with rags dipt in it foment for a while the parts affected, and then anoint them with *unguent populeum*. This

do, if need be, three or four times a day; and if the tumours be internal, you may then inject a little of the formentioned urine.

CLXXI. *An excellent Remedy for Scorbatic and other Pains in the Limbs.*

TAKE red and unsophistical oil of petre, and anoint therewith from time to time the part affected.

CLXXII. *An easy, but excellent Poultice to appease Pains and Achs, even Arthritic or Gout Pains.*

TAKE onions, and boil or stew them in water, till they be soft enough to make a poultice; then drain away the water, and beat them; and having spread them to a good thickness upon a linnen cloth, apply them as hot as the patient can well bear; let them keep them on all night.

CLXXIII. *To strengthen a Part weakened by Sublaxation.*

SPREAD *emplastrum divinum* upon soft leather, and apply it, keeping it on for some time.

CLXXIV. *A somewhat rough Emetick, by which the French-Pox has been often cured.*

TAKE good mercury sublimate, and mithridate, or Venice-treacle, of each one ounce; mix them together, and put them into a quart of spring-water; set them in *balneo* to dissolve in a close vessel; and of this liquor, well settled, let the patient take about half a spoonful, or, if need be, a spoonful, but never above a spoonful and a half, in four ounces of small ale warm, fasting in the morning, and once in the afternoon or evening, the stomach being empty. Every second day intermit, and give a gentle purge.

CLXXV. *A choice Medicine for the Palsy.*

TAKE *sarsaparilla* a pound and a half, bark of *guaiacum*, China in chips, of each two ounces and a half; boil all in six pints of water to a consumption of a third part; at the end add raisins of the sun stoned four ounces, liquorish bruised one dram, fat figs number twelve, boil and strain it. Of this let the diseased drink warm, as their ordinary drink.

CLXXVI. *For a Weakness in the Hands, arising from the Palsy, or an ill-cured Rheumatism.*

TAKE the tops of rosemary, and, bruising them a little, make them up into a ball of the bigness of a small orange, or a large walnut with the green husk on. Let the patient often roll one of these balls between his hands, and for divers hours in a day grasp one of them in the hand affected, that it may grow hot there, and transmit its effluvia into the part. Continue this course as long as the distemper requires.

CLXXVII. *A choice external Remedy for Paralytic Affections.*

MAKE a strong decoction of rosemary-leaves (or flowers, if the season afford them) and let the patient hold the part affected for a good while at a time in the liquor kept very warm. If after several trials this medicine prove not effectual enough, take ten drops of oil of worms, and mix with it well four or five drops of oil of

turpentine; and with this mixture, well warmed, anoint the part from time to time, or else let the patient keep the part for a good while together, for more than once or twice, if need require, in warm rain water (to dissolve the scorbutic salts.)

CLXXVIII. *To take off little Pimples, or grating Inequalities within the Eye-Lids.*

TAKE one spoonful of eye-bright water, one spoonful of plantane-water, and half a spoonful of good red-rose-water; mix these, and put to them about 15 grains of choice tutty finely prepared; shake them together, and then let the powder fall to the bottom, and with the clear liquor moisten the eye several times in a day, if it be found needful.

CLXXIX. *For the Pleurisy.*

CUT green broom-tops short, and fill therewith a skillet or pipkin of a pint and a half; then fill it up with ale; boil it softly, till it be waisted to two or three spoonfuls; it will look black like treacle, and be thick. When it is enough, and cold, add as much mithridate as a nutmeg, and mingle it well, and give it the party warm in bed, and let him sweat three hours or more after it, by adding some clothes. If it help not at first, repeat it next day, or the second, not to fail.

CLXXX. *An experienced (and by some good Authors excellent) Medicine for the Pleurisy.*

TAKE as many fresh balls of stone-horse dung, as the horse in good case may disburthen himself of at one time; cover these, whilst they are warm, with good white-wine; let them stand a little to act on one another, and then press out gently through a clean linnen cloth, as much liquor or juice, as the mixture will readily afford; and of this (somewhat warm) give a moderate draught from time to time, as need shall require.

CLXXXI. *A very often experienced Medicine for the Small-Pox (especially in Children.)*

TAKE the little balls of fresh sheep's-dung, and having freed them from straw and dust, and other things foreign to them, put an handful of them thus cleansed into a quart of good white-wine, and in a vessel well stoppt let them infuse in a moderate heat for a night, or till the liquor be well impregnated with the taste and colour of them. Strain this infusion, and give of it warm about a spoonful at a time, once in two or three hours, or oftener, if need require. N. B. In case of necessity, the infusion may be much sooner made, by putting into the wine a greater proportion of the sheep's-dung.

R.

CLXXXII. *A successful Remedy for a kind of Rheumatism, and a Contracture of the Limbs, that followed upon it.*

TAKE the inward bark (that which grows next the wood) of an elder-tree, cut or tear it into small bits, and with them loosely placed fill about a third part of a bottle; then pour in as much small ale or beer, as will fill up the remaining part of the vessel; stop it well, till the liquor be strong of the infusion, and of this let the patient drink a good draught once or twice a day, or, if he can well bear it, let him take it as a diet-drink.

CLXXXIII.

CLXXXIII. *An approved Outward Medicine to cause Rest without Opiates.*

TAKE of rose-water eight ounces, good wine four ounces, strong vinegar two ounces; mix these well, and having warmed stupes in them, foment therewith the part affected, laying them on but moderately warm, but taking them off, when they begin to grow cold: this fomenting may last between a quarter and half an hour, before the patient should compose himself to rest.

S.

CLXXXIV. *A choice and diversified Medicine for the Scurvy.*

FROM the fresh gathered tops of fir, a little bruised, abstract spirit of wine, or at least good Nantes brandy, and with this liquor draw a deep tincture from other fresh tops, of which tincture reduce some part into an extract, whereof to form pills; keep these, the tincture and the impregnated liquor apart, to be employed separately or conjointly, as occasion may require.

CLXXXV. *For an Excoriation, and for preternatural Tenderness of any Part of the Skin.*

TAKE *unguentum diapompholigos*, and spread it thinly upon lint, which must be applied to the part affected, and kept on by a bandage or some sticking plaister.

CLXXXVI. *To take off the Heat and Roughness of the Skin, especially on the Lips.*

ANOINT the part affected with fresh (or at least not too stale) cream.

CLXXXVII. *To take out the Marks of Gun-Powder Shot into the Skin or Face, or elsewhere.*

TAKE fresh cow-dung, and having warmed it a little, apply it as a thin poultice to the part affected, renewing it from time to time, as occasion shall require.

CLXXXVIII. *An Excellent Medicine to Strengthen a weak Sight.*

TAKE eye-bright, penny-royal, rue, celandine, lovage, faxifrage, of each half a handful, blew-bottle-flowers, fennel-seeds, parsley-seeds, of each half a dram, grains of paradise one dram, hyssop, organy, willow-leaves, each half an ounce, galingal three drams, ginger half a dram, cinnamon one dram, sugar half an ounce. Let them be finely powdered, and very well mixt together. Take of this powder one scruple, or half a dram, every day with your dinner.

CLXXXIX. *A distilled Water for Strengthening the Sight.*

TAKE rosemary-flowers, sage, betony, rue, and succory, of each one handful; infuse these in two quarts of good sack, distill them in a copper alembick. The dose is a moderate spoonful.

CXC. *A choice Medicine, which I have several times used for a light stroke or Contusion of the Eye.*

PUT to two ounces of carduus-water, or that of betony, three or four drops of honey; use it every three hours. (But have a care not to keep it above a day or two, lest it grow sour.)

CXC. *A much commended Powder to strengthen the Sight.*

POWDER of eye-bright one ounce, ordinary fennel-seed in powder half an ounce, powder of nutmegs half a quarter of an ounce, double refined sugar two ounces. All these being finely powdered and sifted, are to be mixt together, and taken as much as will lye on a shilling at a time, as often as you please. The powder is to be taken dry, and kept in a box close shut in some dry place. This has done great cures in dimness of sight, and rheums in the eyes.

CXCII. *To make a Drink to be taken like Tea, for strengthening the Sight.*

To a quart of water ready to boil, put in half a handful of eye-bright, and then let the liquor boil for one walm or two, before you take it off to drink instead of tea.

CXCIII. *A rare Water to Strengthen the Sight.*

TAKE clary, and distill it in a cold still; and of the water let the patient take every morning, and, if need be, every night going to bed, from two or three spoonfuls to six, either alone, or sweetened with a little sugar; let him also, with the same water unsweetened, bathe or wash the parts affected in the morning, and at bed-time; and, if need be, once or twice more every day.

CXCIV. *An excellent external Medicine to strengthen the Stomach.*

TAKE wormwood, mint, and mugwort, and by beating them well in a stone or glass mortar, make a cataplasm, to be applied somewhat warm to the stomach, and kept upon it for a pretty while.

CXCV. *An often tried Remedy to strengthen the Stomach, and also to take off griping Pains in or near it. (It is good also for Cold.)*

TAKE *emplastrum stomachicum* of the London dispensatory, and drop upon it five or six drops of oil of cinnamon, rubbing it well over with your finger, and so apply it to the patient's stomach; and after three or four days, or as soon as it grows dry, remove it, and having scraped the plaister, and warmed it on the wrong side, let fall some drops of the oil of cinnamon upon it, or more drops of the cordial spirit, and apply it again.

CXCVI. *An excellent Plaister to strengthen the Stomach, and Chest.*

TAKE of cinnamon, nutmegs, cloves, and mace, of each a sufficient quantity; powder them well, and strew some of the powder all over the bottom of a deal box of a convenient length and breadth, and fit it with a cover to shut close; upon this powder lay a piece of clean flannel well dried, and strew it over thinly with some of the same powder; then lay on another piece of the like flannel of the same dimensions with the former, and upon that likewise, if need be, a little more powder. This done, shut the box, till the time of use, and then take out one of the pieces of flannel, and having lightly dusted off the powder, lay it on the patient's breast, stomach, and belly, and let it lie on there for some days. When you perceive its virtue begin to languish, you must substitute for it the other piece of flannel, and put the first in the box to receive new virtue, and so proceed alternatively as long as you need the medicine, adding now and then some fresh powder, if necessity require,

quire. *Note*, that each piece of flannel ought to be long and large enough to cover the breast, and to reach from about the paps to the navel, or lower.

CXCVII. *For a recent Strain.*

TAKE a pint or more of claret-wine, and boil in it for a little while, in a close vessel, about a handful of red rose-leaves, till the liquor be strong of the plant. In this, well heated, dip a piece of linnen or flannel, and wringing out the moisture, double it, and apply it hot to the part affected, using a fillet, or some such thing, to keep it on.

CXCVIII. *My Lord Bacon's experienced Medicine for a recent Strain or Bruise.*

TAKE a good handful of fresh wormwood, and boil it in a sufficient quantity of strong ale to the softness of a poultice; then take it off the fire, and when you apply it, which you should do whilst it is very hot, put to it a spoonful of good common brandy.

CXCIX. *A choice Plaster for a recent Strain.*

TAKE equal parts of the plaisters called *diapalma* and *oxycroceum*, and make of them a compounded plaister, to be spread upon thin leather, and applied to the part affected, and to be renewed, if need be, twice a day.

CC. *An approved Medicine for a recent Strain.*

APPLY seasonably a cataplasim made of bran boiled in good vinegar, till it be soft enough to make a poultice.

CCI. *A slight but choice Remedy for a recent Strain.*

TAKE two spoonfuls of vinegar, and beat into it very well the white of an egg, and spreading it upon flax or tow, apply it to, and keep it on the part affected.

CCII. *A parable but excellent Medicine in the Fits of the Stone.*

TAKE somewhat less than a handful of red chick-pease, or cicers, and boil them softly in a quart of spring-water, till the liquor be red and well impregnated with the seeds; strain this decoction, and sweeten it with syrup of marsh-mallows, out of which all the stronger diureticks are left.

CCIII. *For the Stone.*

TAKE a quart or half a pint of simple arsmart-water; sweeten it with a little sugar, or some convenient syrup, and aromatize it with a little nutmeg scraped, and give this mixture for one dose.

CCIV. *For the Stone and Gravel in the Reins and Bladder.*

TAKE equal weights of common daucus-seeds, and of burdock-seed, and having mixt these together, put one ounce of the mixture to a gallon of small ale, and let the patient use it as a constant drink.

CCVI. *A*

CCV. *A good Liquor, to use as Drink in a long Fit of the Stone.*

MAKE posset-drink of three or four parts at most of milk, and one of white-wine. Into two quarts of posset drink scrape or thinly slice a nutmeg and a half, or two nutmegs; add a little juice of lemon to your palate, and, if you please, sweeten it a little with syrup of marsh-mallows. Take of this drink a pretty quantity at a time, and use it often in a day.

CCVI. *A good Medicine for the Stone.*

TAKE a pint or a quart of ale, somewhat new, sweeten it with pure honey, and boil it to the consumption of about one half, skimming it well from time to time. Then dissolve in it the yolk of a new-laid egg; and let the patient drink a good draught of this mixture once or twice a day, until he find relief thereby.

CCVII. *A choice Medicine in an actual Fit of the Stone.*

TAKE the decoction made according to the London dispensatory for the syrup of marsh-mallows, with this difference that to the same quantity of water you must take but half the quantities of each of the ingredients. Let this corrected decoction be well clarified, and let the patient take it warm, six, eight, or ten ounces at a draught, from time to time, as need shall require.

CCVIII. *The Stone, and the Cure. Taken out of the History of Barbadoes, written by Rich. Lygon, Gent. p. 118, 119.*

AFTER the stoppage of urine more than fourteen days, the following medicine did not only break, but brought away all the stones and gravel: and about three weeks after, the like pains returning, the same medicine did the like effect within ten hours after the taking thereof.

TAKE the pizzle of a green turtle (or tortoise) which lives in the sea; dry it with a moderate heat; pound it in a mortar to powder, and take of this as much as will lie upon a shilling, in beer, ale, white-wine, or the like; and in a very short time it will do the cure. These are to be had easily, both at the Caribbee and Lucaick islands, where these fishes abound.

CCIX. *A good Medicine in Pains of the Stone, or Cholic.*

TAKE half a pint of good fallet-oil, and as much good sack, (or, if that cannot be had, good claret-wine;) shake them very well together, and give them moderately warm for a clyster.

CCX. *To expel the Stone in a Fit.*

TAKE crabs-eyes powdered, and dissolve a large proportion of them in good white-wine-vinegar, and of this drink let the patient take from two spoonfuls to five or six at a time.

T

CCXI. *An almost specific Remedy for the Tooth-Ach.*

Into a quart of red-wine (or at least of claret) put one drachm of allum and another of acorns, a drachm and a half of galls, and half a handful of good dried rose-leaves.

leaves. Boil this to a consumption of near half, and then take it from the fire and strain it, and dissolve in it a drachm of acacia cut into small bits; and with this liquor, a little hot, you must wash the parts several times in a day.

CCXII. *An uncommon, but not unuseful Remedy for the Tooth-Ach.*

LET the patient lie on the ear, that is opposite to the part affected, and into the other ear drop two or three drops of the freshly expressed juice of rue a little warm, and stop the ear lightly with fine black wooll or cotton.

CCXIII. *An odd, but very successful external Remedy for the Tooth-Ach.*

IN the declining of the moon in *August*, take the fruit called hipps, viz. those of the wild-brier, with all the furzy stuff, that grows upon it; and lapping it up in a piece of thin sarcenet, tie it upon the arm, that is on the same side with the part affected, and keep it on as long as there is need.

CCXIV. *For the Tooth-Ach.*

TAKE a handful of red sage, and a handful of clary; shred them small, and beat them; sprinkle them with May-dew; then strain out the juice, put it in a glass bottle, and set it in the sun in a window; and when you use it, put three drops into a spoon, and heat it over a candle blood-warm, and drop it into the ear, and let them eat a crust of bread wet either in broth or posset, and chew it upon the teeth, that ach.

CCXV. *An approved Medicine for an Aching Tooth, that is hollow.*

TAKE two parts of common pepper ground to fine powder, and mix exactly with it one part of sugar moderately fine over a gentle heat; form these into a small pill of a shape and bigness fit for your purpose; and when your stuff grows cold, it will harden, and may be applied, when you please, to the part affected.

CCXVI. *An excellent Remedy to fasten Teeth.*

TAKE of burnt allum, acorns, of each one drachm, galls a drachm and a half, red roses half a handful. Beat all these together, and make them boil in about a quart of good red wine, to the consumption of about a fourth part. Then strain the decoction, and dissolve in the transmitted liquor, of good acacia cut into very small bits half a drachm. With this decoction the mouth is to be washed several times in a day.

CCXVII. *To fasten the Teeth.*

PUT mastic finely powdered upon the end of an handkerchief, rub your teeth therewith twice or thrice in a day, and chew mastic often. Also boil pomegranate-flowers with mint or mastic, in red or claret wine; gargle or wash your mouth often with it.

CCXVIII. *A Medicine prescribed to a great Prince, (Charles the First) to fasten the Teeth*

TAKE a pint of spring-water, and put to it four ounces of brandy; let the patient wash his mouth with the mixture of these every morning, and twice or thrice a day

day besides; and let him in the morning rowl for a little while a bit of roch-allum to and fro in his mouth.

CCXIX. *A good Astringent Liquor to fasten the Teeth.*

To four ounces of Claret-wine, or some other convenient menstruum, you may put to dissolve about four drachms of terra Japonica.

CCXX. *An excellent Medicine to fasten the Teeth in Scorbutic Gums.*

TAKE of choice bole-armoniac two drachms, choice myrrh (not lucid) one drachm, roch-allum crude half a drachm, claret-wine one pint; boil these softly a little while together, and let the patient use twice, thrice (or, if need be, oftner) in a day.

CCXXI. *To fasten Teeth made loose by the Scurvy.*

ANOINT the parts affected with oleum myrrhæ made by deliquium, with whites of eggs, boiled hard.

CCXXII. *A Lotion to fasten the Teeth.*

IN a quart of spring-water decoct for a while one ounce of the best terra Japonica reduced to gross powder; and then having filtered the decoction, keep it close stopt for use.

CCXXIII. *A good Astringent Liquor to fasten loose Teeth.*

IN a pint of red wine infuse about half an ounce of terra Japonica, until as much as will be dissolved be taken up by the liquor. Decant it from the fæces (if there be need) and keep it well stopt for use.

CCXXIV. *An useful Liquor to fasten the Teeth, and prevent the Tooth-Ach.*

To a pint of spring-water put half an ounce of clean sal armoniac, and with the solution of this salt let the patient wash his mouth from time to time.

CCXXV. *To make an excellent Poultice to ripen Tumours.*

TAKE eight ounces of (fat) figs, two ounces of white-lilly-roots, and two ounces of bean-flower (or meal:) boil these together in water, and reduce them to the consistence of a poultice; which is to be spread to a good thickness, and laid warm enough upon the part, and shifted as often as it begins to grow dry.

CCXXVI. *An excellent Medicine to relieve those, that are troubled with Tumours in the Throat, and some other Parts.*

To a quart of new-milk put a handful of mallow leaves, with as much of the leaves of folanum, or nightshade; shred them small, let them boil, till the herbs be tender, as if they were to be eaten. Then put into the milk as much crumbs of white-bread, as, being stirred well with the other ingredients, will bring all to the consistence of a poultice. This is to be spread upon a stay for the throat, or some other thing fit to be applied to any other part affected, and is to be laid on as hot as the patient can well endure it; and when it begins to grow cold, it is to be succeeded by fresh made very hot, and so long as the case shall require.

CCXXVII. *A Medicine, that lately cured an obstinate Tumour of the Knee, that had baffled some Chirurgeons.*

TAKE a green colewort-leaf with red veins or streaks, and having cut the ribs flat and almost level to the rest of the leaf, bruise it with the haft of a knife, or some such thing; apply it to the part affected, renewing it once or twice a day.

CCXXVIII. *A powerful and experienced Topic for a sore Throat.*

Take two new-laid eggs roasted moderately hard, and the pap of two well roasted pippins; beat them well together, and add to them as much curds of posset made with ale. Having incorporated them all very well, apply the mixture very warm to the part affected, shifting it, if need be, once in five or six hours.

CCXXIX. *An approved Remedy for a sore Throat.*

TAKE verjuice of grapes one ounce, good honey half an ounce, crude allum about a drachm and a half, and sea-salt half a drachm; powder the salts finely, and incorporate them very well with the liquors into the form of a kind of a liniment. In this dip a long feather, or a piece of rag tied about the end of a slender stick (as of liquorish,) and with it touch the part affected three, four, or five times; between each two times gargling with a mixture of plantane-water, and some red rose-water.

CCXXX. *A choice external Remedy for a sore Throat.*

TAKE millepedes, sow's or hog's lice alive, and sew them up between the foldings of a piece of linen, and apply them to the throat in the form of a stay, which is to be kept on all night.

CCXXXI. *An easy, but tried Remedy for a sore Throat.*

TAKE bay-salt dried, and having pounded it, put it into the folds of a rag, in a sufficient quantity to make a stay to be tied about the throat, and apply it over night, as hot as the patient can conveniently endure it.

CCXXXII. *A choice Remedy for a sore Throat, especially if inflamed.*

TAKE a little handful of the leaves of common mallows, and eight or ten good figs; boil these about a quarter of an hour in a pint of new milk, and let the patient use it very hot and often.

CCXXXIII. *A homely, but experienced Medicine for a sore Throat.*

TAKE about one drachm of album Græcum, or white dog's-turd, burnt to a perfect whiteness, and with about one ounce of honey of roses, or clarified honey, make thereof a linctus, to be very slowly let down the throat.

CCXXXIV. *A homely, but experienced Medicine for a sore Throat.*

INTO the leg of a worsted stocking, that has been long worn next to the flesh, put in a sufficient quantity of good sea-salt exactly dried, or else decripated; and this salt being put in warm, if not hot, the stocking is to be tied about the patient's neck, and kept on all night. And if by the next day the distemper be not removed, you may apply fresh salt (in the proportion) in the same stocking as before, the night following.

CCXXXV. *A tried Medicine for a sore Throat, caused by acid Humours in the internal Parts of it.*

TAKE half a handful of the leaves of common mallows, and boil them in about a pint of new milk near half an hour; then let it run through a clean cloth, and let the patient use it a little warm three or four times a day as a gargle; or else let him use it by holding it in his mouth, letting some drops slowly slide down his throat.

CCXXXVI. *An often experienced Remedy for Tettars and the Itch.*

TAKE flowers of sulphur finely powdered, ginger and burnt allum, each alike, save that of the allum there must be somewhat less. Incorporate these with as much fresh butter, (without any salt) as will bring them to the consistence of an ointment: with this anoint the part affected at bed-time, as hot as the patient can well endure it, and let it lay on all night; wash it off in the morning with celandine-water well heated; and whilst you continue the use of this medicine, take daily some cordial, to keep the noxious humour from being driven inwards. This will not fail to do the work.

CCXXXVII. *A choice Medicine for a Thrush in young Children, or a sore Mouth.*

TAKE an egg, and put out the meat, then fill it with the juice of red sage, and set it on hot embers untill it boil; then skim it, whilst any skum doth arise. Then take as much allum beaten, as the bigness of a pea or bean, and half a spoonful of honey, and let this be put in the egg, and boil it a little, and so take it off; and when it is cold, rub the child's mouth as oft as you see cause.

CCXXXVIII. *An almost specific Medicine for a Tenesmus.*

Mix balsam of sulphur made with oil of turpentine, with linseed-oil, or some other convenient oil, till the balsam be thereby so far allayed, that the patient may well endure it; and then let him dip his finger in it, and make use of it as a small suppository two or three times, or, if need be, ofner in a day.

U.

CCXXXIX. *An excellent Emulsion to be used in Sharpness of Urine, especially caused by blistering Plaisters.*

TAKE mallows two handfuls, gum Arabick two drams, brandy-water a sufficient quantity; boil all to a quart, to which add sweet almonds blanch'd one ounce, of the four great cold seeds, of each two drachms. Make an emulsion, strain, and add two ounces of syrup of marsh-mallows, of which drink at pleasure.

CCXL. *A powerful Medicine for Stoppage of Urine.*

FRY chervil with a sufficient quantity of oil of walnuts, and apply a cataplasm made of it very hot to the navel (and, if need be, to the *os pubis*, or share-bone.)

CCXLI. *For a Retention of Urine.*

TAKE chervil, and with fresh hog's-lard fry it well, and lay it very hot upon the patient's navel, and all the adjacent parts, shifting it, if there be need, once or twice.

CCXLII. *An*

CCXLII. *An useful Powder for such as cannot hold their Urine.*

TAKE root of the male piony, yellow amber, red coral, and choice gum Arabick, of each a sufficient quantity: reduce them to fine powder, mix them well, and let the patient take of this mixture from ten to twenty grains twice a day.

CCXLIII. *An easy Medicine for sharpness of Urine, and for obstruction of the Menfes, and their flowing too much, if the Distemper be not obstinate.*

GIVE about half an ounce at a time of the newly expressed juice of ground-ivy in any convenient vehicle.

CCXLIV. *An old Lithotomist's Medicine for Suppression of Urine, (given me by himself.)*

GIVE from about fifty grains to one drachm for a dose of the *pulvis Holandi*, and if the necessity be very urgent, you may give from one drachm to four scruples, or a drachm and half, not neglecting in the mean while other proper remedies.

CCXLV. *For Suppression of Urine.*

GIVE about a spoonful at a time of bruised mustard seed in any convenient vehicle.

CCXLVI. *A tried Medicine for a Suppression of Urine, that is not very obstinate.*

DISSOLVE half an ounce of choice Castile soap in half a pint of white-wine, or some appropriated liquor; pass the solution through a woollen filter, that the more greasy parts may rest behind, and the liquor pass more clear; put to this five or six grains of saffron: divide it into two doses, whereof one is to be given some few hours after the other, if the first do not operate well.

CCXLVII. *A speedy Remedy for Fits of Vomiting.*

TAKE a large nutmeg, grate off one half of it, and toast the flat side of the other, until the oily part begin to ouze or sweat out; then clap it to the pit of the patient's stomach as hot as he can well endure it, and let him keep it on whilst it continues warm, and then, if need be, put on another.

CCXLVIII. *To make an astringent Liquor, of great use in Ulcers and (some) Wounds.*

BOIL two drachms of choice catechu, or Japan earth, in a quart of spring-water; pour off the clear, and with it, by injection or otherwise, dress the ulcers or wounds.

CCXLIX. *For outward Ulcers.*

TAKE the green bark of oak, and chop it all together, both inside and outside, into very small pieces. Upon these pour good lime-water freshly made, and let him infuse in it, till the liquor has acquired a deep tincture. With this dress the ulcer once, and, if need require, twice a day.

CCL. *The famous Scotch empirical Medicine for a stubborn Ulcer.*

BURN to ashes, but not too much, the gross stalks, on which the red colewort (not cabbage) grows, and with any fit additament, make thereof a cataplasim to be applied to the ulcer, and shift it at reasonable distances of time.

CCLI. *A Remedy against the Bitings of Vipers, and other venomous Creatures.*

As soon as ever one is bitten (for if the poison be diffused through the mass of blood, the experiment may not succeed) a hot iron may be held as near the wound, as the patient can possibly endure, till it has, as they speak, drawn out all the poison, which will sometimes adhere like a yellowish spot to the surface of the iron.

CCLII. *A Medicine against voiding of Blood out of several Parts.*

TAKE two drachms of henbane-seed, and the like weight of white poppy-seed; beat them up with an ounce of conserve of red roses, of which give to the quantity of a nutmeg or walnut.

Or, take the expressed juice of twelve handfals of plantane-leaves, and six ounces of fresh comfrey-roots, well beaten together with a convenient quantity of fine sugar. These two medicines have wonderful effects to stop bleeding.

CCLIII. *A simple, but powerful Remedy for fresh Wounds.*

TAKE the juice of celandine, and dress with it recent wounds and cuts, instead of a balsam.

CCLIV. *To make a simple, but excellent Balsam to stanch the Blood of fresh Wounds newly made, and to heal them speedily.*

TAKE good Venice-turpentine, and in a limbeck, or some other convenient vessel, distill off a good part of it with a very moderate fire, till there remains a thick substance, yet not like colophony, but of a liquid and balsamic consistence. What you have distilled off set aside for other uses, for the remaining substance is what we now seek for, and is to be applied as a balsam both *per se*, and with pledgets and other helps.

CCLV. *An excellent Wound-Drink.*

TAKE hart's-tongue, liverwort, wood-bugle, wood-sage, wood-betony, southern-wood, wormwood, alehoof, bugloss, scabious, ribwort, white-bottles, mugwort, comfrey, mint, agrimony, strawberry and violet leaves, cinquefoil, daisy-leaves, roots, and flowers, wild honeysuckles, wild angelica, avens, plantane, clowns, wound-wort, hawthorn-buds, oak-buds, and bramble-buds.

Gather these herbs in *May*, or as many as can then be had; the buds in *March* as soon as ever they put forth, before they come to leaves; measure them, and take equal quantities of them, and dry them severally in the shade, and, when thoroughly dried, put them up in bags, and so keep them for use.

How to make the Drink.

TAKE one gallon of spring-water, one pottle of the best white-wine, add to this two good handfals of all the herbs, mingled well together being dried; but if green, then one good handful of each. Boil them in a pipkin or iron-pot to the consumption of the half; then strain it out, and put to the liquor a quart of honey, and let it boil again, and skim it, and when it is cold, put it up into bottles stoppt very close; then let the patient drink thereof morning and evening about a quarter of a pint at a time (some use only three spoonfals at a time) fasting after taking of it one hour or two. Observe, the liverwort is ever best to be put in green. If you make use of this for any sore or ulcer in the body, lay any searcloth or plaister to it, of unguentum

unguentum apostol. or minium, or such like, as they use for wounds in the body, or a plaister of honey and wax.

This drink is effectual for sores old or new, women's breasts, putrified bones, causing them to scale; it is good for any ach in the stomach, for the king's evil it hath cured; also caused bullets in the flesh to come out, having long continued there. Sir Jo. Mince was healed by drinking of this, being wounded through the loins.

CCLVI. *A quick Remedy for a small and fresh Cut, or Wound.*

LET the patient speedily plunge the hurt part into brandy, and keep it there for a while, until the pain, which will be excited, be extinguished, or much abated: or, if the part be unfit for this operation, the liquor may be applied to it immediately with a soft sponge, &c.

CCLVII. *A good Vehicle for divers Remedies, and that is itself useful against the Jaundice, and Worms in Children.*

THE distilled water of the husks of walnuts is a very good vehicle in divers diseases, particularly in jaundices; it is a cordial, and exceeding proper to be mixt with juleps in fevers. It is also an excellent antiverminary, or medicine against the worms, especially for children.

CCLVIII. *A powerful Medicine for white Fluors (and the like Distempers.)*

TAKE a pottle of ale, and shred into it two ounces of white ichthyocolla (isinglass,) and in a loosely stoppt vessel let the liquor simmer, till about half is wasted; strain the rest, and give of it two or three ounces at a time once or twice a day, as need shall require.

CCLIX. *A tried Medicine for an Ulcus Uteri.*

TAKE of true and choice bitumen Judaicum, or asphaltum, and having reduced it to very fine powder, let the patient take of it about a drachm at a time in any proper vehicle, once or twice a day.

CCLX. *An excellent Water to preserve the Sight.*

To half an ounce of celandine-water, and two drachms of succory-water, mixt together, put two or three drops of clarified honey, and shake them all together, when you are to use them. Of this water let fall a drop or two into the eye once or twice a day. It will not keep above three or four days, especially in summer, and therefore must be often renewed.

CCLXI. *A tried Medicine for a Whitloe.*

TAKE house-snails and beat them, shells and all, in a stone or wooden mortar, so long, till they be reduced to the consistence of a cataplasm; which apply somewhat warm to the part affected, and keep it on for sixteen or twenty-four hours, renewing it then, if need be.

CCLXII. *A powerful dissolving Ointment for Warts and divers Tumours.*

TAKE May butter, and having melted it in a moderate heat, mix with it very diligently, but by little and little, as much oil of tartar *per deliq.* as will give it a sensible, but not a considerably strong taste.

CCLXIII. *An*

CCLXIII. *An experienced Remedy for Bloody Water.*

TAKE waters of the black alder, of mallows, of each three ounces, syrup of comfrey one ounce: mix them, and let the patient take four spoonfuls immediately; and four or five times a day.

CCLXIV. *To make a well experimented Lime-Water.*

TAKE fresh quick-lime two pounds, on which pour two gallons of water boiling hot; when they have stood together about twenty-four hours, pour off the clear, and into one gallon of this put of anniseeds, liquorish, and saffrafs thinly sliced, of each four ounces. Let them infuse for twenty-four or forty-eight hours in a covered vessel; then take a pound and a half of Smyrna raisins (which some call great blue currans) washed and stamped. Let these infuse for a few hours, and then pass the whole mixture first through a sieve, and then through a woollen bag. The dose is about a quarter of a pint warm twice a day.

CCLXV. *An experienced Medicine to correct the peccant Humour in the King's-Evil.*

TAKE half an ounce of cuttle-bone dried, till it may be finely powdered. Give this to the patient for one dose.

CCLXVI. *An excellent and often tried Clyster in Fluxes, especially in sharp Humours, and some other Distempers of the Bowels.*

IN a quart of new milk boil softly two small spoonfuls of grossly powdered rice, till it be brought to the consistence of cream, then dissolve it in two ounces of our suet of sheeps kidneys, and having strained it to keep back the fibres, give it at once for a lavement.

CCLXVII. *A cure for Schrophulas, and the King's Evil.*

TAKE a handful of *paronychia folio rutaceo*, called rue whitlow-grass, and by some felonwort; boil it every morning in a quart of small beer, strain it, and drink it for your ordinary drink. It wastes the peccant humour, appeases the pains, discusses the unbroken tumours, and heals the broken ones.

CCLXVIII. *Against Epilepsies, or the Falling-Sickness.*

TAKE of the powder of the true misseeltoe of the oak, as much as will lie upon a sixpence, early in the morning, in black-cherry-water, for some days near the full moon.

CCLXIX. *A simple Remedy for the Stone.*

TAKE *Periscaria*, or arsesmart, as much as you please: distill it in a common rose-water-still, and give some spoonfuls of it in or before the fits.

CCLXX. *An excellent Remedy against Fluxes.*

TAKE unsalted butter, boil it gently, till a pretty part be consumed, skimming it diligently from time to time, whilst it stands over the fire: of this butter melted give now and then a considerable quantity, as the patient is able to bear it. This medicine was very successful in Ireland.

A

S U P P L E M E N T

T O

Mr. BOYLE'S COLLECTIONS

O F

SAFE and CHOICE REMEDIES

Taken from his own Manuscripts, added to the Fourth Edition.

CCLXXI. *An excellent and often experienced Medicine for Convulsions, especially in Children.*

TAKE a pound of the true single piony-roots, scrape and slice them as thin as paper into three pints of white-wine; infuse it all night on embers in a pipkin close covered and pasted up: in the morning strain it out hard, and put in a quarter of an ounce of castor in fine powder, an ounce of the best spirit of castor, thirty grains of the moss of a dead man's skull, and thirty grains of the skull itself: put all these into a strong glass, that is very dry, and shake them half an hour with all your might. It may be given in a fit: a spoonful to a young child; to a man, or a woman, a wine-glass. I usually mix black-cherry-water with it.

CCLXXII. *The Pills for the Dropsy, that are much used by a Person esteemed for the Cures he has done on that Disease.*

TAKE gambogia, gum ammoniacum, of each a dram and a half; diagridium, and tartar-vitriolate, a dram; with syrup of buckthorn: make a mass for pills. Dose from fifteen grains to half a dram.

CCLXXIII. *An easy but effectual Medicine for the Roughness of the Lips, and to heal Parts that have the Scarf-skin worn off.*

TAKE two parts of wax, and one of the freshest butter; melt and incorporate them over a gentle fire, and then let the mixture drop into small cakes upon a glazed tile or a plate (whether pewter or silver) dipt in water, or else upon a piece of wetted white paper.

CCLXXIV. *A good and tried Way to make an artificial Wine, that is soon drinkable, and serves to keep the Body soluble.*

TAKE a gallon of boiling water, and pour it upon three pounds of raisins of the sun stoned and well bruised; by squeezing and pressing get out the juice as thoroughly

as you can from the skins, &c. and, having strained, put to it a pound of brown sugar-candy.

CCLXXV. *A not unpleasant Purge for Children and delicate Persons.*

IN the yolk of an egg dissolve, by rubbing them very well in a clean glass or stone mortar, about six grains of choice resin of jalap finely powdered, and, when the solution is made, incorporate with it, little by little, two or three ounces of succory or some other convenient water, which by this operation will be turned white, and make a kind of emulsion, which you must sweeten at pleasure, either with fine sugar or some laxative syrup, and give it in a morning fasting. *Cum custodia.*

CCLXXVI. *An ingenious Chymist's Arcana for the Stone.*

TAKE borax, finely powdered, and make it up with some choice turpentine into pills, whereof one dose ought to contain from a scruple to two scruples; wash these down with some few spoonfuls of the tincture of *lignum nephrcticum* made in water, or of cochineal; or, if the case be urgent, you may give from twenty to thirty grains of the borax, and about a fifth part of myrrh; dissolve in a couple of spoonfuls of the tincture of *lignum nephrcticum*.

CCLXXVII. *An uncommon but tried Medicine to make a quick Exfoliation of a carious Bone.*

TAKE the thigh-bone of a hanged person, (if it can be had of such a body, else another may be substituted) and having burnt it to blackness, but not calcined it, reduce it to fine powder, which is to be carefully strewed all over the part to be exfoliated, after some drops of chymical *oleum sabine* have been employed to wet and soften the part, and make the powder stick well; this done, dress it up S. A. and it will seldom require a third (if it do a second) application.

CCLXXVIII. *An experienced Medicine for Madness (Mania) not very obstinate.*

TAKE two ounces of the berries of box, and infuse them warm in a close vessel in a quart of claret, or red-wine, for forty-eight hours; then decant the liquor, and put to it an equal quantity of the distilled water of vervain, and of this mixture let the patient take six or eight ounces at a time, and compose himself to sweat and rest after it. This must be daily done for a pretty while together, if need requires.

CCLXXIX. *To prevent a Gangrene upon a great Pain, and to strengthen the Part.*

TAKE of melilot-plaister and diapalma equal parts, and having melted and well incorporated them together, make thereof a thin plaister; which, being prickt full of holes, is to be laid upon the inflamed or bruised part, first lightly scarified.

CCLXXX. *An excellent Plaister to discuss Tumours, (even scrophulous) that may be resolved, and ripening those that it cannot dissipate.*

Incorporate exactly with the *emplastrum de sapone* about a fourth part of *balsamum sulphuris terebinthinati*, and use it as a plaister for the above-mentioned purposes. N. B. In want of this, you may employ *diachylon cum gummis*, renewing it once in two or three days.

CCLXXXI.

CCLXXXI. *A parable Medicine to drive away Gravel and small Stones.*

TAKE the thick skin, that is found in the gizzard of a cock or hen, (but not a capon) and having warily dried it, till it be grown pulverable, give from a scruple to two scruples of it in a draught of any convenient vehicle.

CCLXXXII. *An excellent Remedy for Whitloes on the Fingers.*

TAKE a reddish or at least a blackish snail, of that sort that has no house or shell, and having beaten it in a mortar, that is not metalline, to the consistence of a poultice, apply it to the part affected, renewing it, if need be, once or twice, after it has been kept on for some hours.

CCLXXXIII. *To make one spit out Rheum, that swells the Gums, and therewith causeth the Tooth-Ach.*

DISSOLVE a spoonful of good mustard in about a pint of French wine (claret or white), and having warmed it a little, let the patient from time to time wash his mouth with it, and hold it therein for a pretty while together.

CCLXXXIV. *To give Ease in the Fit of the Gout.*

TAKE three parts of oil of turpentine, and one of chymical oil of spike; shake them well together; with this mixture anoint the parts lightly.

CCLXXXV. *An excellent Eye-water to preserve from Rheums, especially sharp ones.*

TAKE two parts of celandine, and one of eye-bright, and distil thence (N. B.) in balneo, a water or liquor, which you must put upon exquisitely pulverized *lapis calaminaris*, and let them digest together in an exactly closed vessel for some weeks, adding, before you use it, a third part of brandy; afterwards continue upon the powder as long as you employ the liquor.

CCLXXXVI. *To make an excellent and often tried Medicine for the Stone, whether of the Kidneys or Bladder.*

TAKE of pure white-wine, or rhenish-wine, and of fennel-water, each one pint: into this mixture put half an ounce of wood-lice, alive and well cleansed, of a middling size, and one lemon sliced; let them infuse in a vessel well stoppt, for three, four, or five days, and then let the patient take about four ounces at a time twice a day.

CCLXXXVII. *An almost specific Remedy for the Thrush in Children.*

TAKE housleek freshly gathered, crush it well between two plates, or otherwise, till you have squeezed out the juice, mix this with live honey, enough to make it somewhat sweet, and then put to it as much finely powdered roch-allom as will give it a little tartness; put some of this mixture with a quill, or a feather, down the patient's throat, as far as conveniently may be; if there be need, the part affected may be touched once more within an hour after.

CCLXXXVIII. *For the Yellow-Jaundice.*

TAKE rhubarb two drams, saffron, mace, of each a dram, hemp-seed one handful; bruise them, and put therein a quart of white-wine, and set it in a gentle heat

to extract; then take, mornings and evenings in an empty stomach, about a quarter of a pint; and when all is spent, pour on some more wine upon the ingredients, adding a little fresh rhubarb and saffron, and use it as before.

CCLXXXIX. *An almost specific Medicine for Agues.*

TAKE resin of scammony twelve grains, diaphoretic antimony, and crystals of tartar, of each eight grains; mix these carefully, and give them for one dose, an hour before the fit comes.

CCXC. *To make a nephritic Tincture, often found to relieve in the Stone.*

TAKE oyster-shells, and calcine them, till they be very white; of these take two parts, and one of rhenish-wine-tartar; pulverise these apart very well, and then mix them diligently; pour on the mixture a little fair water, and let the ingredients work on each other, till the conflict be over; then stir the mixture with a stick, and pour on some more liquor; and when the effervescence ceases, put on a little more, and so proceed till no conflict be made. Evaporate to a kind of soft mucilage; digest this a while; decant the liquor and filter it, and you will have it, if it be not too flegmatic, of a fine red colour. Of this the dose is from ten or fifteen to thirty drops, or more, in any convenient vehicle.

CCXCI. *An almost specific Medicine for Exulceration in the Kidneys.*

TAKE jet, and, having reduced it to fine powder, give of it about half a dram. for a dose, in some good white-wine, in the morning fasting, and at bed-time, for some days together.

CCXCII. *An almost specific Medicine for the Jaundice.*

WITH small ale, or at least not very strong, draw a deep green tincture from fresh sheep's-dung, and, in a small draught of this, give from half a dram to a dram of a powdered mixture, consisting of four parts of turmeric, and one of English saffron. This dose may be given twice, or, if need be, thrice a day, having a care that the patient, whom it will dispose to sweat, keep very warm, and so whilst the operation lasts.

CCXCIII. *An useful medicinal Aliment for those who are troubled with Pains of the Stone.*

LET the patient eat five or six onions roasted, and sparingly buttered, either in the morning fasting, or at meals, or at other times, if the case be urgent. [N. B.] The distilled water of onions is likewise of good use in the same distemper.

CCXCIV. *An experienced Ointment for the Worms in Children.*

TAKE rue, wormwood, and fabine, of each a sufficient quantity, and with May or other unsalted butter, or else with fresh hogs-lard, boil the herbs softly, till you have brought the mixture to be very green; then strain it, and pot it up for use: when you employ it, anoint with it first the pit of the stomach, and part of the chest a little above it, and then after a while rub it pretty well upon and all about the navel.

CCXCV. *An*

CCXCV. *An often tried Cataplasme to break a sore Breast.*

To the yolks of four eggs, take four ounces of live honey; mix them by grinding well together with about half a pint of red or claret wine, and apply this mixture as a kind of poultice to the part affected.

CCXCVI. *For an Ague.*

TAKE the foot that is in a baker's chimney, and mustard, and rue, and white-wine vinegar, and fallad-oil, and some white-pepper and ginger, and make a poultice of it, and lay it to the pulse of his or her arms, and let it lie for a fortnight or three weeks, if you lay it on just before the fit come.

CCXCVII. *A very often experienced Medicine for Cankers in the Mouth, and elsewhere.*

TAKE flowers of sulphur one ounce, roch-allum, crude and finely pulverised, half an ounce; mix these very well together, and incorporate them with as much good honey, as will serve to bring the mixture to the consistence of a liniment, to be applied from time to time to the part affected.

CCXCVIII. *An easy but very effectual Medicine to stop bleeding in Wounds, and check some other Hemorrhages.*

STREW upon the part the powder of clear rosin beaten very small.

CCXCIX. *A very good Drink for Children, whose sore Eyes are suspected to be scrophulous.*

TAKE of ground-ivy and arch-angel, (leaves, flowers, and all) of each half an handful: pour on them a pint of boiling spring-water, and proceed as in making of coffee; let the patient drink a moderate cup of this two, three, or four times a day; but if you would have it stronger, you may put to a quarter of a handful of each of these, two or three drams of pile-wort-roots, which must be put to infuse all night alone in the water, which, being thus impregnated, must then boil, and be used as before.

CCC. *For scrophulous Humours of Children's Eyes and other Parts.*

TAKE figwort, and put two handfuls of it to a pottle of small ale; of this give a quarter or half a pint at a dose. The operation will be promoted by quenching seven or eight times in this liquor a gad of steel about eight or ten inches long.

CCCI. *Against a Vertigo.*

TAKE of cyprus-roots two ounces, of aniseed half an ounce; make of both a very fine powder, and take as much as you can lay on a sixpence, in a spoonful of wine, beer, or ale, when you go to bed. This medicine continued for five nights (besides other patients) cured a woman, who for divers years was troubled with a vertigo, and had used all sorts of other remedies, prescribed to her by London physicians, to little or no purpose.

M E D I C I N A L E X P E R I M E N T S :

O R, A

C O L L E C T I O N

O F C H O I C E

R E M E D I E S,

Chiefly SIMPLE, and easily Prepared :

Useful in FAMILIES, and fitted for the Service of COUNTRY PEOPLE.

The P R E F A C E.

THE Hon. ROBERT BOYLE, Esq; deceased, hath gratified the whole race of mankind by his public labours. The world may be divided into the learned and the unlearned part thereof. The former he much obliged by his elaborate discourses on several subjects; the latter, which are far more numerous, he hath condescended also to oblige, by consulting their health in the ensuing receipts. For, whereas the ordinary and inferior sort of men either have not ability (by reason of the tenuity of their estates) to reward physicians, or, by reason of the remoteness of their habitations, have not opportunity to consult them; here they have remedies provided to their hands, and almost at their own doors; some of which the learned collector had experience of himself; and others were recommended to him by credible persons, who had experienced their benefit in themselves or their friends.

AND though those ways of probation might be sufficient to justify their publication; yet such was the scrupulous care and zeal of this author, that he would not suffer them to see the light, till they had been first perused by some eminent physicians of his acquaintance, to whom he was pleased to commit the supervisal of his medicinal receipts, both galenical and chymical.

THIS century bears the name of parable receipts, because they may be easily procured and prepared by country people, as their respective diseases do require.

WHAT comes forth in the name of Mr. BOYLE, and is genuinely his, needs no farther recommendation.

HIS *ipse dixit* is sufficient, and such are these prescripts, as being found among his many other papers of like import, which in time may be published also.

I SHALL therefore only recommend them and their success to the blessing of GOD, the alone Giver, Preserver, and Restorer of health.

J. W.

A COL-

A
C O L L E C T I O N
Of C H O I C E and S A F E
R E M E D I E S.
THE THIRD VOLUME.

I. *A good Medicine for a newly taken though violent Cold.*

TAKE about four ounces of spring-water, and, in a convenient vessel, put to it three leaves of good tussilago (colts foot) and a pugil of maiden-hair, and a stick of liquorish for bigness and length like the furthest joint of the little finger: make the water warm, and, when it is ready to boil, put in the forementioned ingredients, the liquorish being first sliced and minced; cover the pot well; let it boil for a few whalms; then take it off the fire, and, having presently strained it, let the patient drink it hot like tea, he being already in bed: do this three or four nights consecutively, or till there be no more need of the medicine.

II. *A good Water for the Eyes, that are foul, and pained by sharp Humours.*

TAKE prepared pearl and coral, *anà* one scruple, aloes cabalina, finely powdered three grains, red rose-water and succory-water *anà* one ounce; mix them well, and if you would have the mixture stronger, put in a very few grains of *trochisci albi rasis* in very fine powder.

III. *A good Medicine for Pain of the Teeth, that comes from Rheum.*

OF the powder of white hellebore, put into a clean linen rag, like a nodule, of about the bigness of the largest fort of pease, or somewhat greater; and let the patient hold it between his teeth, with his head and face somewhat inclined, that the rheum may run freely out of his mouth.

IV. *An experienced Sternutatory to clear the Head.*

LET the patient snuff up, in the morning fasting, a small spoonful, or less, of the clarified juice of *hedera terrestris*, *i. e.* ground-ivy, or of beets, spitting out from time to time as much liquor as comes into his mouth.

V. *An often tried Remedy for the Dysentery and sharp Fluxes of the Belly.*

GIVE from fifteen to twenty grains of carefully made *mercurius dulcis*, incorporated with about two ounces of catholicon, or else with about one scruple of toasted or somewhat less of untoasted rhubarb. See Numb. (1.)

VI. *A good though uncommon Medicine for the Dropsy.*

TAKE Virginian snake-weed a sufficient quantity, and, having cut and sliced it very small, infuse it into a competent quantity of good sack, till the liquor be very strongly

strongly impregnated with the plant. Of this infusion let the patient take three, four, or five spoonfuls at a time (or more, if the case be urgent) when the stomach is empty. See Numb. (2.)

VII. *An often experienced Medicine for bloodshot or inflamed Eyes.*

Cut a new-laid egg, boiled hard, into two halves, without taking out the yolks, and apply one of these considerably warm, but not too hot, to the part affected, and keep it on for some hours (six or eight, if it need so long.) Note well; to the same purpose you may apply, with good effect, a poultice made of a rotten apple, the cold being first quite taken off. See Numb. (3.)

VIII. *An excellent Remedy for a Burn or Scald in the Eye.*

TAKE mucilages of quince-seed, flea-wort, linseed and fenugreek-seed, of each one scruple; boil it very lightly in four ounces of betony-water, filter it, and apply it to the part.

IX. *A good and innocent Dentrifice.*

TAKE mastic and dragons-blood, of each a sufficient quantity; powder them, and mix them together, and let the patient use them as a dentrifice.
See Numb. (4.)

X. *To correct the Laxity of the Gums, and fasten the Teeth.*

To a pint of red or claret-wine take about two drams of Japan earth, and having dissolved so much as you can, pour off the clear, and let the patient wash his mouth therewith from time to time.

XI. *An uncommon but effectual Fomentation for Tumors accompanied with sharp Humours.*

To a gallon of spring-water put as much dried sage as you judge will afford a decoction strong enough of the herb: into this, when it first grows hot, cast about two ounces or some drams of Castile-soap, and let it dissolve there till your decoction be completed: with this, and stupes, foment the part for a good while together.

XII. *A rare Medicine for hysterical Affections, and several Distempers of the genus nervosum.*

TAKE one ounce, or a sufficient quantity of volatile salt of harts-horn, which need not be exactly pure, and drop on it as much spirit of tartar as will serve to satiate it, when the conflict is quite ceased. Digest the mixture for a while, that it may acquire a red colour, and keep it carefully stopt for use, and give four or five drops twice a day in any convenient vehicle.

XIII. *An often proved Remedy to bring away what is, or should not be left, in the Womb of a Puerpera, though it were Part of a dead Child.*

With the juice of sheep's-forrel, and some of the strong infusion of the same herb (unpressed) in water, and a sufficient quantity of sugar, make a syrup; of which let the patient take about a spoonful (a little more or less, as need may require) twice or thrice a day.

XIV. *A tried Medicine to take away Corns.*

THE parts being made soft with bathing, and scraped, apply to the corn a plaister of shoe-maker's wax; but, if the part be very tender, your plaister may consist of equal parts of shoe-maker's wax and diapalma melted together, and spread somewhat thin.

XV. *To make an excellent styptic Powder to staunch Blood.*

TAKE of white sugar-candy, roch allom burnt (but not too much calcined) and white vitriol, and pulverize them exceeding well, and mix them diligently, and having dipt pledgets of wax or lint, moistened with the white of an egg, into this powder, apply them to the orifices of the bleeding parts. Note well; it will do very well, after the dry ingredients are mixed, to grind them with as much whites of eggs, beaten to water, as will make a paste, which is afterwards to be thoroughly dried in the air, and then again reduced to powder.

XVI. *For a Tooth-ach proceeding from Defluxions or Rheum from the Gums.*

DISSOLVE one ounce of choice Japan earth in a pint at least of good red or claret wine, and let the patient hold it in his mouth often, and a good while together.

XVII. *To prevent the Fit of an Ague, or cure that Disease.*

TAKE of the scraping or gratings of the root of angelica half a dram, and of the flowers of antimony; mix them well, and let the patient take them at the usual times.

Note here, that the flowers of antimony are not to be given inwardly in substance, but only in infusion; for in substance they will hazard life, bringing first strong convulsions, and then death. But you may make the medicine thus.

See Numb. (5.)

XVIII. *To make an often tried Pericarpium for Agues, especially Tertians.*

TAKE a handful and a half of fresh rue, half a handful of fresh sage, a spoonful of bay-salt, a spoonful of good vinegar: beat all these very well together into an uniform mass; which divide into two parts, and make thereof two wrist-plaisters, to be applied at the usual times before the fit; and to be renewed, if there be occasion, to keep them on, till they grow dry and troublesome.

XIX. *For the Cholick.*

R. Orange-peels dried, till one may grate them to powder; and when they are pulverized, take about a spoonful of the powder at a time, mixed with a little white sugar to sweeten it, in or before some spoonfuls of any convenient vehicle:

XX. *An approved Remedy for present Deafness.*

TAKE of the breast-milk of a woman, that has had her first male-child some time before, and drop three or four drops of it warm, as it comes from the nipple, into the part affected.

XXI. *A choice Medicine for Burns.*

TAKE goose-grease (which the country-people call the leaf of a goose) and having softly melted and a little skimmed it, squeeze into it as much freshly exprest juice

of ground-ivy-leaves, as, by continual stirring, will bring it to the consistence of a green ointment. With this anoint the part itself affected, and afterwards lay on it fine rags well dipt in the same ointment.

XXII. *An external Remedy, almost specific for the Leprosy.*

TAKE pomatum one ounce, flower of sulphur one dram, *sal prunellæ* half an ounce; and, having mixed them very well together, from time to time anoint the part affected therewith, as long as there is need.

XXIII. *For the Head-Ach.*

TAKE green hemlock, that is tender, and put it in your socks, so that it may lie thinly between them and the soles of your feet; shift the herbs once a day.

XXIV. *For the Hiccup (even in Fevers.)*

GIVE two or three preserved damsons at a time.

XXV. *A simple Remedy for the Cholic.*

IN a draught of any convenient liquor, dissolve about one dram of good salt of tartar, and let the patient take it for one dose.

XXVI. *An experienced Medicine to cleanse the Womb.*

TAKE a large white onion, cut it into small pieces, and boil it in about a pint of water, or less, as if it were to be dressed for eating; and of this decoction give seven or eight ounces for a dose, mixed with about half an ounce of fresh oil of walnuts.

XXVII. *To appease the Fits of a Furor uterinus.*

TAKE the feathers of partridges (it matters not much from what part of the fowl) and burn them for a competent time under the patient's nose.

XXVIII. *A very good Syrup to strengthen the Sight.*

TAKE about a spoonful of a syrup made of betony-water and honey, twice, thrice, or four times a day.

XXIX. *An easy prepared but useful Drink for a beginning Scurvy.*

TO a quart of small-beer (of six shillings per barrel) or small ale, put over-night about a handful of scurvy-grass-leaves, and let the patient drink this liquor at dinner for his ordinary drink for six or eight weeks together.

XXX. *A parable Remedy for recent Burns.*

APPLY, as speedily as you can, to the part affected, an onion, or more (if the burnt place be large) beaten to massh.

XXXI. *For the Tooth-Ach.*

APPLY a plaister of *caranna* to that part that burns, between the bottom of the ear and the temples, on the same side where the pulsation of the artery is the most manifestly or strongly felt.

XXXII. *An*

XXXII. *An excellent Medicine, though not curative, for those that are tormented with the Stone in the Bladder.*

TAKE powder of comfrey-roots an ounce and half, marsh-mallow-roots three ounces, liquorice-powder two drams, seeds of daucus of Crete two drams, seeds of purslane, of winter-cherries, of each half a dram, nutmegs two drams, saffron one dram, the species *diamargariton* frigid six drams, syrup of marsh-mallows four ounces; mix and make a soft electuary, of which let the sick daily take the quantity of a walnut. It is profitable against the stone in the reins and bladder, but chiefly against the latter; as also against the strangury, dysuria, &c.

XXXIII. *To make a purging Electuary, especially for Children.*

TAKE an ounce of choice rhubarb reduced to fine powder, and eight ounces of very good currans picked, washed, and rubbed dry; beat these together in a glass or marble mortar for near two hours. Of this electuary let the patient take about the bigness of a small or large chesnut in the morning fasting, and, if need be, at bed-time. If the case be very urgent, the medicine may be taken thrice in twenty-four hours.

XXXIV. *An excellent Remedy for an Inflammation in the Eyes.*

TAKE a pippin (or other apple) cut it into two halves, take out all the core of each of them, fill up the cavities with the tender tops of common wormwood, tie the halves together, and roast the apple well; then beat it and the herb together to a kind of poultice, and apply it warm (but not hot) to the part affected, and bind it thereon, letting it lye all night, or, if you use it in the day-time, for six or eight hours.

XXXV. *An useful Drink for the King's Evil, and some Affections that have the like Cause to it.*

TAKE a large handful (or two little physical handfuls) of the leaves of ground-ivy, green, or (if the season denies you them) well dried; wash off the dust with beer, not water, and put the herb into a gallon of alewort; when it is ripe for drinking, draw it out into bottles, and let the patient take a draught of it twice or thrice a day, or, if it be thought fit, it may be used at meals. See Numb. (6.)

XXXVI. *An often experienced Remedy to expel Gravel, and provoke supprest Urine.*

KILL a black cock or hen (rather than one of any other colour) take out the thick membrane or skin that lines the gizzard or stomach; and, having wiped it clean, dry it cautiously, so as it may be beaten to powder. With this mix an equal part, or half so much of choice red coral calcined: of this mixture give from twenty or thirty to forty or fifty grains. See Numb. (7.)

XXXVII. *An approved Remedy for the King's Evil.*

SET a quart of new-milk on the fire, till it just boils up; then take it off, and put into it two spoonfuls of the best honey, and stir it till it be dissolved; and then set it on the fire again, and let it boil two or three walms: then divide it into four parts, and drink one part warm, early in the morning, another about ten of the clock, another about four in the afternoon, and the last a little before bed-time. Do this daily for two or three months, except you purge, which must be once a week,

taking (if a grown man) three quarters of an ounce of *caryocostinum* dissolved in posset-drink: dress the sores, if they run, with any drawing sear-cloth, or a plaister of Burgundy-pitch. The medicine, though not very promising, is very famous by the many cures done with it by a charitable lady, of whose ingenious chaplain I procured this.

XXXVIII. *A good Composition to stop a hollow Tooth, and appease the Pain.*

TAKE two parts of fine sugar (that of *Lisbon* does best) and one part of black round pepper, both finely powdered and mixed; put them into a silver spoon over two or three well-kindled coals; and, when the sugar begins to melt, take off the spoon; and, whilst the mixture is yet soft, form it into little grains for size and shape suited to the part affected.

XXXIX. *A Plaister preferred by an ancient Physician, that often tried it, to the common Soap-Plaister.*

Mix about a dram of Castile-soap with one ounce of diachylum, and make thereof a thin plaister to be worn upon the part affected.

XL. *An excellent Medicine to be used topically in Gleetings.*

TAKE four ounces of spring-water [or plantane-water] and dissolve in it about one scruple of the sympathetic powder, or so much as will give it a sensible yet but faint vitriol-like taste: and of this mixture inject as much as is usual of a small syringe every morning and evening, as long as need require, directing the patient to retain the injected liquor as long as conveniently he can.

XLI. *An approved Medicine in the Biting of a Viper.*

TAKE of white hore-hound, and apply the plant well beaten into the form of a poultice to the part affected, and give the patient a spoonful or two of the juice of the same herb to drink: it is also very good for the jaundice.

XLII. *An almost specific Medicine for the Suppression of Urine.*

TAKE of *stachas citrina* (in English, French lavender) and infuse in a good heat two handfuls of the flowers in a pint of good brandy (not rectified spirit of wine) and of this infusion give about a small wine-glass full at a time (diluted, if there be great need, with a sufficient quantity of some appropriated liquor.)

XLIII. *For an Ague, often tried.*

Boil yarrow (*millefolium*) in new-milk, till it be tender enough to have a cataplasim made of it. Apply this to the patient's wrists, just when the cold fit is coming on, and let it lie on the parts till the fit be gone; and if another fit comes, use fresh cataplasms as before.

XLIV. *An useful Plaister for those that are troubled with Vapours of the Spleen, and Shortness of Breath, when it is a nervous Affection.*

TAKE two parts of strained galbanum, and one part of assa foetida, and make thereof, according to art, a plaister of about the bigness of the palm of one's hand,
taking

taking care to leave a broad edge quite round, to prevent its sticking to one's linen, and putting a pretty large piece of cotton in the middle, that the gums may not touch the navel, to which the plaister is to be applied.

XLV. *A slight but excellent Medicine to take off Fits of the Head-Ach.*

TAKE about a handful of fresh rosemary, and boil it for a pretty while in a quart of common water; then almost fill with it a pint-pot (or rather a mug); let the patient cover his head and face with a napkin, so that he may receive the steam as hot as he can well bear, and keep the vessel there as long as he finds the steam strong enough.

XLVI. *An easy and dry Medicine for the Itch, præmissis universalibus.*

BOIL four ounces of clean quicksilver in about a gallon and a half of spring-water, and let the patient take of this between a quarter and half a pint at a time, aromatizing it, if he pleases, with a little lemon-peel.

XLVII. *An easy Medicine to purify and sweeten the Blood.*

TAKE the minera of Hungaria, or other choice antimony, and, having ground it to very fine powder, without suffering it to touch any metal, give of this dry alcohol from ten grains to a dram, giving it once a day, and (unless some particular reason dissuade that time) let it be at dinner, that it may mingle with the patient's meat in his stomach.

XLVIII. *A cheap but excellent Medicine for Ulcers.*

TAKE one drachm, at least, of corrosive sublimate finely powdered; dissolve it in a quart of fair water, and let it lie there, if you have leisure, four or five days (in a slight digestion) that it may be thoroughly dissolved. Then drop in it as much spirit of sal armoniac, or as much oil of tartar *per deliquium*, as will precipitate it all: then filter it carefully, and keep it stopt for use, which is to imbibe dossils or pledgets with it, and apply them to the ulcer twice or thrice a day.

XLIX. *An easy and innocent Medicine for Costiveness.*

BOIL, in as much broth as will serve to fill a large porringer, about half a handful of the leaves of common mallows chopped; and of this broth (being strained) let the patient make the first part of his meal.

See Numb. 8.

L. *For the aching of a hollow Tooth.*

TAKE oil of wax, and with it moisten well a little cotton, and thrust it up into the hollow tooth, letting it lie there until the pain be sufficiently asswaged.

LI. *An often-tried Medicine for the bloody Flux, being good also for Pleurifies.*

GIVE the weight of an escu d'or (or near one drachm) of the seed of *sophia chirurgorum*, in English, flax-weed, in two or three spoonfuls of any convenient vehicle, once or twice a day.

LII. *The*

LII. *The Cinnamon-Drink, good in Gripes and Fluxes, &c.*

TAKE two ounces of calcined harts-horn, powder it, and boil it in three pints of spring-water till a pint be wasted; then take it off the fire, and infuse in it an ounce and half of good cinnamon, setting it upon embers in a covered vessel for about an hour. Then sweeten it with sugar to your palate, and drink about a quarter of a pint at a time. If taken for prevention only, a fourth part of the cinnamon will serve the turn. See Numb. (9.)

LIII. *An easy but useful Remedy for Redness of the Eyes.*

TAKE a blanched almond, and about three grains of camphire, and, in a glass or marble mortar, incorporate them by wary grinding; and then add to them, little by little, two or three ounces of red rose-water, still grinding them, till the whole be brought to a kind of emulsion. Drop a little of this into the part affected.

See Numb. (10.)

LIV. *A most excellent Balsam for any green Wound, of what Nature soever.*

OIL of St. John's-wort, and Venice-turpentine, of each a like quantity; set them over the fire in a gentle heat, half an hour or less, that they may incorporate. Then put them up, and keep it for use, as one of the best of balsams.

LV. *A good Medicine for the Suppression of the Menses.*

GIVE for three mornings together, about the expected time of the monthly evacuation, a drachm, or drachm and half, or thereabouts, of the galls and livers of eels dried and made into powder.

LVI. *An experienced Remedy to prevent apoplectic Fits.*

MAKE, at the crossing of the futures, an issue with diapalma and oil of vitriol, and keep it open the ordinary way.

LVII. *To dry up or correct the Humour that makes scrophulous Ulcers.*

TAKE of the bone of the cuttlefish, and, having reduced it to an impalpable powder, give about one dram of it at a time in any convenient vehicle.

LVIII. *An effectual Medicine for a recent Strain.*

TAKE a handful of wormwood-leaves, and boil them in strong ale, till the consumption of about a third, that you may reduce them to the form of a cataplasm, which, when you take from the fire, you must strengthen by putting into it two, or at most three, of brandy, and apply it warm, renewing it, if need be, in twenty-four hours at least. See Numb. (11.)

LIX. *For a slight Inflammation of the Eyes, as also a Hordeum growing on the Eye-lid.*

TAKE fresh housleek; and, having pounded it very well to a kind of cataplasm, cover as much as is needful of it, for example-sake, to the thickness of an half-crown, or a crown-piece, in the fold of a rag or linen cloth, which may be so applied, that the cataplasm may reach the eye, and the rest of the cloth be fastened about the patient's head. Let the medicine lie on all night, and be taken off the next morning. Repeat this application two or three times, in case there be need.

LX. *For*

LX. *For most asthmatic Distempers.*

TAKE of the roots of elecampane, thinly sliced, one ounce, of the leaves of ground-ivy a good handful. Boil these in three pints of spring-water to a quart; then strain the decoction, sweeten it with a little live honey, and let the patient take it five, six, or seven spoonfuls at a time. (Note well, remember the efficacy of saffron in the same disease, as it is commended by Mr. Ray, in his catalogue of plants.)

See Numb. (12.)

LXI. *For an Ague.*

TAKE of the bone called platella, of the knee of a dead man, and, having reduced it to fine powder, give of it as much as will lie upon a groat or a six-pence, for one dose, in any proper conserve, or fit vehicle, at a convenient time (before the cold fit.)

LXII. *An experienced Medicine to kill Tetters.*

TAKE of flowers of brimstone, ginger, and burnt allum, of each alike; mingle them well, and of this mixture incorporate as much with new unsalted butter as is requisite to bring it to the consistence of an unguent. With this anoint the part affected, as hot as the patient can well endure it, and let it stay on all night, and the next morning wash it off with celandine-water. But, when the patient goes to bed, he is to take a dose of some alexipharmical medicine, as *Gascoign's* powder, treacle, &c. to keep the humour from being driven into the mass of blood: he is also to bathe the part oftentimes in a day with the celandine-water.

LXIII. *To make a good Powder for a Gonorrhœa.*

TAKE of choice red coral, and of mastic equal parts; reduce them separately to fine powder; mingle them very well, and of this mixture give about thirty or forty grains for one dose.

LXIV. *A choice Medicine for a slight Stroke or Bruise of the Eye.*

TAKE two spoonfuls of fennel-water, or of betony-water, and drop into it three or four drops (or five at most) of good clarified honey: shake them well together, and use them twice or thrice a day. But you must have a care to make this mixture fresh once in four (or at most in five) days, especially in summer; for if it be longer kept, it will be apt to grow sour.

LXV. *An often tried external Medicine for an Erysipelas.*

TAKE the blood of a hare (it is best if killed by hunting in *March*) and, if you can have it fresh, anoint the part affected with it; otherwise apply on it a linen rag, that has (though a good while ago) thoroughly imbibed the fresh blood of that animal, and dried in the air. But, if the imbrued linen be too hard or stiff, it must be softened with a little fair water, and then, the cold taken off, applied to and bound upon the part. See Numb. (13.)

LXVI. *An Empiric's much boasted Remedy for the Fluor albus, or Whites in Women.*

MAKE a strong decoction of the herb alchymilla (in English, ladies-mantle) and let the patient drink of it about half a pint every morning fasting; and if the case be urgent, make an injection of the same plant, boiled until it be very tender, and let the patient make use of it from time to time. See Numb. (14.)

LXVII. *An excellent Water for Ulcers and Sores. Tried with great Success.*

TO a quart of spring-water, take one dram of mercury sublimate finely powdered; and, when it is quite dissolved, drop into the solution either spirit of sal armoniac (which is best) or oil of tartar *per deliquium*, until you see that no more will manifestly precipitate. This done, filter the mixture through cap-paper, and reserve the precipitate for other uses. The liquor, that passes, you must keep close stopt in a glass vial; and when you will use it, you must dip linen rags in it, and being thoroughly wetted, apply them to the part affected, single or double, more or less, as need requires. This application may be renewed twice, or (if the case be urgent) thrice a day.

LXVIII. *An experienced Medicine for Want of Sleep, proceeding from great Heats in the Head.*

TAKE the palest carrots you can get, and scrape a sufficient quantity of them to afford scrapings enough to make a cataplasm of about two fingers (or two inches) broad, and of the thickness of a half-crown-piece of silver, or thereabouts. Let the patient apply this in a piece of double linen to his throat, so that it may reach to the jugular vessels on each side, when he goes to bed, and let it lie on all night (for it will not easily grow dry); if the first application do not prevail, it is to be applied the following night; and so a third and fourth time, if need require.

LXIX. *A parable Medicine, that has cured very many, especially Children, and young Boys and Girls, of convulsive Fits.*

TAKE of the powder (whether made by filing, rasping, or otherwise) of the sound skull of a dead man, and give of it about as much as will lie upon a groat, made up into a bolus, with conserve of rosemary-flowers (or any other that is proper) to a young boy or girl: but, in persons more aged and strong, the dose of the powder must be augmented to double the quantity. The medicine must be given often, if necessity requires it: if the patient be a child, it will be useful to apply to the throat a kind of necklace, made of the roots of vervain cut into beads.

LXX. *An easy and experienced Remedy for the Piles.*

IN four ounces of spring-water dissolve about one drachm of salt of tartar, or as much as will give the liquor a manifest but not strong alcalisate taste; and apply soft rags dipt in lukewarm, or somewhat more, to the part affected, shifting it from time to time.

LXXI. *A successful Medicine for the Fluxes of the Belly.*

TAKE rice-meal, and mix with it about a fifth part of finely powdered and sifted chalk; boil these in water, or (which is better, if it agrees with the patient) in milk, and make thereof a hasty-pudding, to be moderately seasoned with sugar and powdered cinnamon; and let the patient eat it at meals, and, if need be, at some other times.

LXXII. *An often tried Remedy for Corns.*

TAKE the juice of houseleek, and mix it up with about equal parts of the thick barm or yeast that sticks to the barrel, or to the clay that stops it. Of these make a kind of plaister, which, being kept upon the toe for a while, and then, if need be, renewed, will make the corn very soft, and easy to be drawn out and extirpated.

See Numb. (15.)

LXXIII. A

LXXIII. *A good Medicine for Burns and Staunching of Blood.*

DISSOLVE in spring-water, or, which is better, rain-water, as much sugar as will make it a strong solution, and then with a sufficient quantity of linseed-oil, or oil of olives, beat up this liquor, until the oil on it be brought to the consistence of an unguent, with which anoint the part affected, as timely as you can, renewing the application as often as need shall require.

See Numb. (16.)

LXXIV. *An approved Medicine for the bloody Flux, being good also for Pleurisies.*

GIVE two or three scruples of hare's-blood beaten to powder for one dose, to be taken in a spoonful or two (or three) of mint-water, or any other fit vehicle.

LXXV. *A very often (though homely) experienced Remedy for dysenteric and other Fluxes.*

TAKE the fresh dung of a hog (and, if you can, whilst it is yet warm) and boil, in a porringer full of new milk, as much of it as may amount to the bigness of a walnut; and also an equal quantity of fine mutton-suet sliced very thin: when these are well incorporated with the milk, strain them well through a clean linen; and, if there be need, sweeten them a little with loaf-sugar. Let the patient take this warm, once or twice a day.

LXXVI. *A powerful Styptic to staunch Blood, where it can be applied.*

TAKE the fine powder of *lapis hæmatites*, made by grinding it exactly well with an equal or double weight of *sal armoniac*: and of this high-coloured sublimate put a little upon the orifices of the vessel.

LXXVII. *For a slight Redness of the Eyes.*

TAKE of French barley half an ounce, and damask-roses half a handful. Boil them but very little in a pint of spring-water, and with this moisten the part affected.

See Numb. (17.)

LXXVIII. *For the Relaxation of the Uvula.*

TAKE bluish pease, or, in want of them, white ones, and chew them very well, so as to reduce them to the consistence of a poultice. Lay this warm upon the crown of the head, to the breadth and thickness of a five-shilling-piece of silver, or somewhat larger, shifting it in the morning and at bed-time.

See Numb. (18.)

LXXIX. *A powerful Medicine to stop sharp Rheums.*

TAKE a dram of catechu, or Japan earth, and make thereof a decoction in five or six ounces of good white-wine, or else of some distilled water, or other liquor appropriated to the disease. Of this give two or three spoonfuls at night, and in the morning as much also, if need require.

LXXX. *The Frenchman's famous Eye-water.*

TAKE two or three ounces of the water of simple pimpernel, distilled in balneo, and put this into a little pot or porringer of rose-copper; then put into it about the

bigness of a hazel-nut, or a filbert, of strong quicklime: cover the pot, and let the ingredients lie in it, till the liquor hath acquired a bluish colour. Then very warily pour off the clear, and add to it as much live honey as will give a little or but little taste: use it after the wonted manner of such waters; and, if you find it too strong, dilute it a little with water of the same plant, or good spring-water, which, for need, may be used from first to last, instead of the water of pimpernel.

See Numb. (19.)

LXXXI. *Eye-Water.*

TAKE red rose-water, plantane-water, of each an ounce; *tutia* prepared, half a scruple; *lapis lazuli* prepared, six grains; red coral prepared, five grains: mix, and make a *collyrium*, or eye-water.

This, dropped into the eyes, being first well shaken, cures inflammations of the eyes, provided there be no great foulness, nor scrophulous disposition in the patient. It takes off the redness of the eye-lids; if, with a sponge dipt in it, the eye-lids be often wetted, it takes off films very well.

LXXXII. *A safe and useful Medicine to prevent Dryness, and some other Disaffections of the Eyes.*

TAKE of choice virgin-honey two spoonfuls, of succory-water, or the distilled water, four spoonfuls; mix them, and, in a very clean vessel over a very gentle fire, let them evaporate (taking off from time to time any scum that may arise) till the mixture be brought to the consistence of a syrup, or of honey; keep this in a glass close stopped, and make use of it, by letting fall a drop or two (or at most three) of it, at a time, into the eye. See Numb. (20.)

LXXXIII. *The Medicine of a famous Empiric for the Stone.*

TAKE amber (clear or yellow), sea-horse pizzle, and nitre, of each a like quantity; (Note well, in case of ulcerated kidneys put half the quantity of amber, and an eighth part of the nitre of natural balsam). Pulverize each apart, and make them up into pills with Chios (or at least clean Strasburg) turpentine. Take five, six, or seven pills (of about ten to an ounce) morning and evening. See Numb. (21.)

LXXXIV. *An excellent Medicine for Fits of the Mother.*

TAKE *sagapenum* dissolved in vinegar of squills, strained through a sieve, and again inspissated or thickened, *ammoniacum* in like manner prepared, steel prepared, myrrh, *fecula* of briony, of each half a dram, English saffron, *castoreum*, of each a scruple, *borax* two scruples, syrup of *stæchas* a sufficient quantity; mix, and make pills of a convenient bigness to be swallowed; of which take three morning and night, with care.

LXXXV. *A choice Medicine for the Cholick.*

TAKE clean white chalk, and, having dried it with a gentle heat, reduce it to fine powder; wet this powder with the expressed juice of camomile, and let it dry in the air, without the heat either of the fire or of the sun. This done, wet it again with new juice of camomile, and dry it the second time as before. Wet and dry it again the third time, and, if you please, the fourth time; and then reduce the dry mass to fine powder again. Of this powder let the patient take at a time as much as will lie upon a groat or six-pence, in some spoonfuls of wine, or other proper vehicle.

LXXXVI. *Troches of Vipers successfully used to cleanse the Blood, and to strengthen weak Patients.*

TAKE of vipers reduced to fine powder one ounce, diaphoretic antimony half an ounce, clear yellow amber two drams, of starch as much as of all the rest, and of sugar as much as of starch; make them to a fine paste with spirit of wine, and then make them into small cakes, whereof one may serve for a dose.

LXXXVII. *An approved Medicine for scorbutic Gums, and to fasten the Teeth.*

TAKE of white-wine a pint, of allum half an ounce, of juniper-berries, and of red sage and one ounce: boil these together, till a quarter of the liquor be wasted; then put into the remaining part four ounces of honey, and let it boil till the scum be all risen; then filter it, and put into it one dram of *balsamum vitæ*.

See Numb. (22.)

LXXXVIII. *A Caution about the vitriolate Eye-Water.*

TAKE four grains of Roman vitriol, not more, to four ounces of distilled water, either of roses, succory, fennel, &c.

LXXXIX. *A good Medicine for a light Stroke or Contusion of the Eye.*

TAKE half an ounce of celandine-water, and shake well into it three or four drops of clarified honey, and let fall of this into the eye a drop or two, twice or thrice a day.

XC. *An excellent Medicine for a Stroke or Bruise in the Eye.*

TAKE of betony-water and hyssop-water, of each one ounce, and in their mixture stir some blades of saffron, till the liquor be pretty well coloured, and no more. And lastly, add to it four or five drops of clarified honey.

See Numb. (23.)

XCI. *An excellent Remedy to take off Films, and such like Things, from the Eyes.*

TAKE choice bole-armoniac, and reduce it to very fine powder, blow this gently into the eye, once or (at most) twice a day. But, if the patient be subject to, or fearful of, any swelling, heat, or disaffection in the eye-lids, incorporate the powder with a little clarified honey. See Numb. (24.)

XCII. *To strengthen weak Eyes subject to Rheums.*

TAKE *lapis calaminaris* four ounces, rose-water a pint; shake them well together two days. Then let it settle; pour off this water into a little vial, and drop of it in weak eyes, two or three times a day, &c.

XCIII. *A Plaister to strengthen the Eyes, and stop Defluxions on them.*

TAKE of frankincense two drams, olibanum and mastic, and half a dram; mix these well, and reduce them into fine powder; of which a convenient quantity is to be melted and spread upon black ribbon, or some such thing, with a hot knife or spatula, and so presently applied to the temples.

XCIV. *An experienced Remedy for sharp and hot Humours in the Eyes.*

INTO a quart of new milk, already boiling, put about two handfals, or less, of green houfleck, freshly gathered, and chopt small, and let the milk boil on, till it will yield no more curd. Then strain the green posset-drink, and let the patient take every day once or twice a pint (or as near that quantity as he can reach to) sweetened a little, if need be, with fine sugar. The drink may be best taken cold.

XCV. *An excellent Fumigation for Pains in the Eyes, and over-great Dryness of them, and when one fears the Beginning of a Cataract.*

TAKE of fennel, hyssop, betony, celandine, carduus, of each half a handful, or a handful; of the seeds of linseed, quinces, fenugreek, flea-wort, of each half a dram, of French barley one ounce: boil these in two quarts of fair water, and half a pint of white-wine: let the patient hold his head over the fumes for about a quarter of an hour every morning.

XCVI. *For sore Eyes.*

TAKE crumbs of white bread half an ounce, coral and pearl prepared, tutia, white sugar-candy, of each half a dram; powder of red roses a dram and a half, flower of St. John's-wort one dram; and with a sufficient quantity of milk make a cataplasm, or poultice, which spread upon linen cloth, and bind it over the eye.

XCVII. *For Heaviness, and Pain in the Eyes.*

TAKE flowers of melilot, of elder, and of marigolds, of each a small handful, linseed, seeds of fenugreek, flea-wort, cummin, and quinces, of each half a scruple, French barley half an ounce, damask roses half an ounce, spring-water a pint and a half; mix and make a decoction, with which foment the forehead, temples, and eye-brows, being sufficiently warm.

XCVIII. *For a dry Inflammation.*

TAKE of betony, hyssop, rue, wormwood, vervain, as also of sage-flowers, and rosemary-flowers, of each of all these half a handful; (to which may be usefully added, cummin-seeds, fennel-seeds, and carduus-seeds, of each a quarter of an ounce); boil these a little in two or three quarts of fair water, and then let the patient hold his head for about a quarter of an hour over the steam of this decoction, making use of a napkin, to keep the smoak from dissipating, and direct it to the eyes. A while after he may put into them, if it be thought fit, a little clarified honey.

Several necessary NOTES, explicating, illustrating, or enlarging some of the HEADS in the PRECEEDING VOLUME.

Numb. (1.) *For the bloody Flux, or other Fluxes.* See Page 375.

TAKE Japan earth, powder of rhubarb, each equal parts; of which give half a dram at a time every morning fasting.

Numb. (2.) *A good Medicine for the Dropsy.* See p. 376.

NOTE, an infusion of mechoacan in white-wine (an ounce and a half thin sliced to a pint) being infused twenty-four hours, and drank of every morning for some days,

days, is a most admirable thing, and if a little mustard-seed be infused in it, it will be so much the better.

Numb. (3.) *A Medicine for blood-shot or inflamed Eyes.* See p. 376.

THERE is no better remedy for inflamed eyes, than to wash them every day several times with this: Take frogs-spawn-water a pint, salt of tartar a dram; mix and dissolve, and wash therewith.

Numb. (4.) *A good and innocent Dentrifice.* See p. 376.

BUT that, which exceeds all, is a fine powder of red coral, with which you may rub them two or three times a day, and then wash them with water in which *sal prunellæ* is dissolved.

Numb. (5.) *To prevent or cure an Ague.* See p. 377.

TAKE gratings of angelica-root, flowers of antimony, of each half a dram, choice canary three ounces; infuse in a cold place for one or two days, and pour off the clear for two doses: it is a singular good vomit for the cure of agues of all sorts, being given in the morning fasting, four or six hours before the coming of the fit; and if it be not a quotidian ague, then on the intermitting day.

Numb. (6.) *An useful Drink for the King's-Evil.* See p. 379.

THERE is no better thing in the world for the king's-evil, than to give daily some spoonfuls of this following liquor: Take white-wine a quart, juice of pellitory of the wall a pint, spirit of wine half a pint, *sal prunellæ* an ounce; mix and dissolve, then pour off the clear, and sweeten with white sugar. Dose, six spoonfuls morning and night.

Numb. (7.) *An experienced Remedy to expel Gravel, and provoke Urine.* See p. 379.

TAKE the juice of onions two spoonfuls, white-wine half a pint or more; mix them for a draught. It gives present ease, and, if repeated for some time, in a short season cures.

Numb. (8.) *An easy Medicine for Costiveness.* See p. 381.

A turpentine clyster thus made is admirable to cause stools in a very great costiveness: Take Strasburg-turpentine an ounce, yolk of one or two eggs; grind them well together, and put thereto a pint of fat mutton-broth, and exhibit it blood-warm.

Numb. (9.) *A Remedy for Gripes and Fluxes.* See p. 382.

A most excellent remedy for gripings is a tincture of corn poppy-flowers made with common spirit of wine: of this you may give from a spoonful to two spoonfuls, in spirit of opium half an ounce, mixt with black-cherry-water four ounces. This gives ease upon the spot.

Numb. (10.) *A Medicine for Redness of the Eyes.* See p. 382.

IF the redness be with a fierce hot rheum, it is from weakness of the eyes; and then the only remedy is to wash them twice or thrice a day with brandy. There is no danger in it, nor will it smart much.

Numb. (11.)

Numb. (11.) *An effectual Medicine for a Strain.* See p. 382.

TAKE comfrey-roots (beating them to a pulp) half a pound, powder of Japan earth four ounces, spirit of wine a sufficient quantity; mix and apply it to the part.

Numb. (12.) *For most asthmatic Distempers.* See p. 383.

TAKE juice of hyfop, choice honey, of each two pounds: mix, boil, scum, and make a syrup; of which let the sick take four spoonfuls or more, morning, noon, and night.

Numb. (13.) *An experienced Medicine for an Erysipelas.* See p. 383.

THE blood of almost any living creature is found by many experiments to be a specific against an erysipelas, being often anointed on the affect, or cloth dipt in the same being laid moist thereon.

Numb. (14.) *A Remedy for the Whites in Women.* See p. 383.

THE best of Remedies in this case (after due purging) is to give two, three, or four grains of laudanum, and to inject three, four, or six times a day this water:

TAKE spring-water two quarts, white vitriol, roch-allum, of each two ounces: being in powder, mix and dissolve. Let it settle, and use only the clear.

Numb. (15.) *A tried Remedy for Corns.* See p. 384.

TAKE ammoniacum strained, emplastrum diapalma, of each an ounce, arcanum corallinum half an ounce, white precipitate two drachms: mix them well together, and apply it only over the corn, being first cut as close as it conveniently can be.

Numb. (16.) *A Medicine for Burns and Staunching of Blood.* See p. 385.

BUT, for staunching of blood, there are but few medicines which exceed the colcothar of vitriol, whether washed and freed from its salt, or not washed: it is but a common thing, but will do more than a thousand much more ennobled.

Numb. (17.) *For a slight Redness of the Eyes.* See p. 385.

ONE of the best of remedies against redness and inflammation of the eyes, is often to wash them with this water: Take frog-spawn-water a pint, common spirit of wine four ounces; mix them; wash herewith five or six times a day; and at bedtime apply over the fore eyes a cataplasm of a rotten apple.

Numb. (18.) *For the Relaxation of the Uvula.* See p. 385.

THIS common medicine is found very successful: the throat being first gargled with claret-wine, in which a little roch-allum has been dissolved, as hot as it can well be endured; then anoint it with this: Take honey one ounce, powder of elecampane two drachms, pepper in powder half a drachm: mix them, and apply it thrice a day with your finger.

Numb. (19.)

Numb. (19.) *A famous Eye-Water.* See p. 385.

TAKE red rose-water a quart, aloes in fine powder, half an ounce; white vitriol, *vitrum antimonii*, *crocus metallorum*, of each six drachms; mix and digest warm a month; then use the clear water three or four times a day. It has scarcely an equal.

Numb. (20.) *A Medicine to prevent running of the Eyes.* See p. 386.

TAKE white-wine half a pint, dissolve in it white vitriol two drachms; filter or strain, and therein dissolve choice honey two ounces; with this fill the eyes two or three times a day. It is good against most distempers of the eyes.

Numb. (21.) *A Medicine for the Stone.* See p. 386.

TAKE Strasburgh-turpentine two ounces; grind it well with the yolks of eggs, and then mix herewith this following syrup: Take water a pint and a half, *sal prunellæ* an ounce and half; mix and dissolve, and, with honey a pound, boil it into a syrup, which add to the former mixture. Dose, two or three spoonfuls morning and night.

Numb. (22.) *A Medicine for scorbutic Gums, and to fasten the Teeth.* See p. 387.

THERE is nothing fastens the teeth better, than to wash them with this mixture. Take claret-wine a pint, *roch-allum* half an ounce; mix and dissolve, and then add thereto six ounces of strong tincture of Japan-earth, made with common brandy.

Numb. (23.) *For a Stroke or Bruise in the Eye.* See p. 387.

TAKE celandine water three ounces, spirit of saffron one ounce; mix them; with which wash the eyes several times a day; and (if the eyes be very sore, red, or blood-shot) after washing anoint them every time with a little pure virgin-honey.

Numb. (24.) *An excellent Remedy to take off Films from the Eyes.* See p. 387.

TAKE powder of coral levigated one ounce, powder of pearls levigated three drams, crabs-eyes levigated one drachm, virgin-honey two ounces; mix them, and anoint four or five times a day, but chiefly morning and night.

Numb. (25.) *A remedy for the King's-Evil.*

TAKE roots of pile-wort a sufficient quantity; bruise and boil them in hog's-lard, until they are crisp, after which press them hard out; and boil in the like manner as many more fresh roots, and press out again, doing it the third time; then keep the ointment for use, to anoint with morning and night.

Numb. (26.) *A Remedy for the Stone.*

GIVE every morning fasting, and every night going to bed, half a drachm of the powder of winter-cherries in a draught of parsley or arsemart water, or in a glass of white-wine.

A
 DISQUISITION
 ABOUT THE
 FINAL CAUSES
 OF
 NATURAL THINGS:

Wherein it is inquired,

Whether, and (if at all) with what Cautions, a Naturalist should
 admit them?

To which are subjoined, by way of

A P P E N D I X,
 SOME
 UNCOMMON OBSERVATIONS
 ABOUT
 V I T I A T E D S I G H T.

The P R E F A C E.

THERE are not many subjects, in the whole compass of natural philosophy, that better deserve to be inquired into by Christian philosophers, than that which is discoursed of in the following essay. For certainly it becomes such men to have curiosity enough to try at least, whether it can be discovered, that there are any knowable final causes to be considered in the works of nature; since, if we neglect this inquiry, we live in danger of being ungrateful, in overlooking those uses of things, that may give us just cause of admiring and thanking the Author of them, and of losing the benefits, relating as well to philosophy as piety, that the knowledge of them may afford us: and if there be no such things, we are more than in danger to mispend our labour and industry, in fruitless searching for such things as are not to be found. And an inquiry of this kind is now the more seasonable, because two of the chief sects of the modern philosophizers do both of

them, though upon differing grounds, deny, that the naturalist ought at all to trouble or busy himself about final causes. For *Epicurus*, * and most of his followers (for I except some few late ones, especially the learned *Gassendus*) banish the consideration of the ends of things; because the world being, according to them, made by chance, no ends of any thing can be supposed to have been intended. And, on the contrary, † *Monfieur des Cartes*, and most of his followers, suppose all the ends of God in things corporeal to be so sublime, that it were presumption in man to think his reason can extend to discover them. So that, according to these opposite sects, it is either impertinent for us to seek after final causes, or presumptuous to think we may find them. Wherefore I hope I shall be excused, if, having been engaged by some solicitations, wherewith it is needless to trouble the reader, I did not decline to try, what the bare, but attentive, consideration of the subject would suggest to my own thoughts. And though it was easy to foresee, that by this means my friend might miss of receiving, in my essay, divers things that occurred not to me; yet I considered on the other side, that such things would, notwithstanding my silence, be found in the authors that delivered them; and it was very possible, that, by the course I took, I might light upon some thoughts that I should have missed, if I had prepossessed my mind with the opinions of others; which I was the less tempted to do, because an easy prospect of my theme sufficed to let me see I was like to have the Epicureans and Cartesians for my adversaries, not my assistants: and for the school-philosophers, the very slight account, that their master *Aristotle* gives of one of my four questions (for of the rest, as far as I remember, he says little or nothing) gave me small hopes of being aided by them; especially since in this, as in many other questions, they proceed upon grounds that I cannot assent to. Anatomists indeed, and some physicians, have done very laudably upon the uses of the parts of the human body; which I take this occasion to declare, that it may not be suspected, that I do in the least undervalue their happy industry, because I transcribe not passages out of their books: the reasons of which omission are, not only, that I had not any one book of anatomy at hand, when I was writing, but that the uses of the parts of man's body related but to a small part of my discourse; to make which more comprehensive, I took in the consideration of more general questions, besides that which was controverted between *Aristotle* and the ancients philosophers, who disputed how bodies, that were devoid of knowledge, could act for ends.

THOSE, that relish no books in natural philosophy but such as abound in experiments, are seasonably advertised, that I do not invite them to read this treatise; wherein I thought it much more suitable to the nature of my subject and design, to declare the works of God, than of men; and consequently to deliver rather observations, than artificial experiments. And even of the former of these, though perhaps most readers may find, in the ensuing discourse, several that they have not met with in classic authors, yet I shall freely acknowledge, that, upon the review I made of what I writ, I find, though too late to repair the omission, that I have left several things unmentioned, that would have been very pertinent to my subject; which may, I hope, be more easily excused, because, the body of the following disquisition having been written many years ago, and thrown by upon the death of the ‡ gentleman, that pressed me for it, I could not then take notice of those

* *Illud in his rebus vitium vehementer inesto, Effugere illorumque errorem præmeditemus, Lumina qui faciunt oculorum clara creata prospicere ut possimus*—*Lucr. de rer. nat. lib. IV. sect. 824.*

† *Ita denique nullas unquam rationes circa res naturales, a fine, quem Deus aut natura in iis faciendis sibi proposuit, desumemus; qui non tantum nobis debemus arrogare ut ejus consiliorum participes esse putemus: Cartesius princip. philosoph. parte prima, artic. 28.*

‡ Mr. Henry Oldenburg, Secretary to the Royal Society.

many discoveries in anatomy, and other parts of physiology, that have since been happily made. But perhaps some will think I may have more need to excuse the largeness of some parts of the following treatise, compared with the others. And I should rather grant than answer the objection, if I could not alledge, that the contagious boldness of some baptized Epicureans engaged me to dwell much longer on the third proposition of the fourth section than I at first intended. And, on the other hand, the Cartesian opinion having of late made it requisite to handle the formerly difficult question, about the consideration of final causes, after a new manner, I thought it unfit lightly to pass over the paradox maintained by so great a man, and judged it expedient in some places (what I could not do without enlarging) to propose thoughts adjusted to the present state of things in this affair; in the management of which, I have had so much more regard to some other things, than to the symmetry of the parts whereof this tract consists, that I will not say that I fear I have in it but thrown together materials for a just discourse on my subject; since to do so was the main thing I intended. And if the materials be good and solid, they will easily, in so learned an age as this, find an architect, that will dispose them in a more artful way than I was either at leisure or solicitous to do.

A N
E S S A Y,

INQUIRING

Whether, and how, a NATURALIST should consider FINAL
CAUSES.

To my very learned Friend Mr. H. O.

S I R,

THOUGH in a book or two of mine, that you have already been pleased to peruse, there are some passages, whence you may easily enough gather what I thought about your questions; yet, because the subject is of great moment, as well as difficulty, and you may suspect I have altered my opinion, I shall, without referring you to writings, which perhaps neither you nor I have at hand, set down succinctly, but yet as if I had said nothing of any of them before, my present thoughts about these four questions:

I. WHETHER, generally or indefinitely speaking, there be any final causes of things corporeal, knowable by naturalists?

II. WHETHER, if the first question be resolved in the affirmative, we may consider final causes in all sorts of bodies, or only in some peculiarly qualified ones?

III. WHE-

III. WHETHER, or in what sense, the acting for ends may be ascribed to an un-intelligent (and even inanimate) body?

IV. AND lastly, how far, and with what cautions, arguments may be framed upon the supposition of final causes?

S E C T. I.

TO begin with the first question. Those, that would exclude final causes from the consideration of the naturalist, are wont to do it (for aught I have observed) upon one of these two accounts: either that, with *Epicurus*, they think the world was the production of atoms and chance, without any intervention of a Deity; and that consequently it is improper and vain to seek for final causes in the effects of chance: or that they judge, with *Des Cartes*, that, God being an omniscient agent, it is rash and presumptuous for men to think, that they know, or can investigate, what ends He proposed to Himself in his actions about his creatures. The ground, on which the Epicureans have rejected final causes, has been disallowed by the philosophers of almost all other sects; and some have written sufficient confutations of it, which therefore I shall here forbear to insist on; though some things I shall upon occasion observe, that may help, if not suffice, to discredit so unreasonable an opinion. But the Cartesian argument has been so prevalent among many learned and ingenious men, that it will be worth while (if it be but to excite better pens) to spend some time in the consideration of it.

PERHAPS one thing, that alienated that excellent philosopher from allowing the consideration of final causes in physics, was, that the school-philosophers, and many other learned men, are wont to propose it too unwarily, as if there were no creature in the world that was not solely, or at least chiefly, designed for the service or benefit of man; insomuch, that I remember I have seen a body of divinity, published by a famous writer, wherein, to prove the opinion he favours, of those, that would have the world annihilated after the day of judgment, he urges this argument; that since the world was made for the sake of man in his travelling condition (*hominis viatoris causa*) when once man is possessed of his everlasting state of happiness or misery, there will be no further use of the world. The opinion, that gives rise to such presumptuous and unwarrantable expressions, did, as I guess by his objection, more shock *Des Cartes*, than I wonder, that it should displease him. But the indiscretion of men ought not to prejudice truth; which must not be cast away, with the unwarrantable conceits, that some men have pinned upon it.

WHEREFORE, since I cannot entirely close, either with the opinion of the Epicureans, or of the Cartesians, I shall leave each party to maintain its own opinion, and proceed to propose mine; for the clearing of which, and indeed of the disquisition of final causes, I shall beg leave to premise a distinction, which, though novel, I shall venture to employ, because it comprises and distinguishes some things, which I think ought neither to be overlooked nor confounded.

I CONCEIVE then, that when we speak of the ends, which nature, or rather the Author of nature, is said to have in things corporeal, one of these four things may be signified, or, if you like that expression better, the end designed by nature may be fourfold:

FIRST, there may be some grand and general ends of the whole world, such as the exercising and displaying the Creator's immense power and admirable wisdom, the communication of his goodness, and the admiration and thanks due to Him from his intelligent creatures, for these his divine excellencies, whose productions manifest

his glory. And these ends, because they regard the creation of the whole universe, I call the universal ends of God or nature.

SECONDLY, in a somewhat more restrained sense, there may be ends designed in the number, fabric, placing, and ways of moving the great masses of matter, that, for their bulks or qualities, are considerable parts of the world; since it is very probable, that these bodies, such as the sun, moon, and fixed stars, and the terraqueous globe, and perhaps each of its two chief parts, the earth and the sea, were so framed and placed, as not only to be capable of persevering in their own present state, but also as was most conducive to the universal ends of the creation, and the good of the whole world, whereof they are notable parts. Upon which account these ends may, for distinction's sake, be called cosmical or systematical, as regarding the symmetry of the great system of the world.

THERE is a third sort of ends, that do more peculiarly concern the parts of animals, (and probably plants too) which are those, that the particular parts of animals are destined to, and for the welfare of the whole animal himself, as he is an entire and distinct system of organized parts, destined to preserve himself and propagate his species, upon such a theatre (as the land, water, or air) as his structure and circumstances determine him to act his part on. And these ends, to discriminate them from others, may be called animal ends.

FOURTHLY, and lastly, there is another sort of ends, which, because they relate particularly to man, may, for brevity's sake, be called human ends; which are those that are aimed at by nature, where she is said to frame animals and vegetables, and other of her productions, for the use of man. And these ends themselves may be distinguished into mental, that relate to his mind, and corporeal, that relate to his body, not only as he is an animal, framed, like other animals, for his own preservation, and the propagation of his species (mankind); but also as he is framed for dominion over other animals and works of nature, and fitted to make them subservient to the destinations, that one may suppose to have been made of them to his service and benefit.

THIS distinction of final causes, which, I hope, will not prove altogether useless, being premised, I shall begin my intended discourse, by owning a dissent from both the opposite opinions; theirs, that, with the vulgar of learned men, will take no notice of final causes but those we have stiled human ones; and theirs, that (as they think with *Des Cartes*) reject final causes altogether; since, though I judge it erroneous to say in the strictest sense, that every thing in the visible world was made for the use of man, yet I think it is more erroneous to deny, that any thing was made for ends investigable by man.

It is a known principle of the Cartesian philosophy, that there is always just the same quantity of motion in the world at one time that there is at another: of which assertion this reason is given, that there is no cause, why God, who is immutable, should at the beginning of things, when He first put matter into motion, have given it such a quantity of motion, as would need to be afterwards augmented or lessened. But I see not how, by this negative way of arguing, those, that employ it, do not (implicitly at least) take upon them to judge of the ends, that God may have proposed to Himself in natural things. For, without a supposition, that they know what God designed in setting matter a-moving, it is hard for them to shew, that his design could not be such, as might be best accomplished by sometimes adding to, and sometimes taking from, the quantity of motion He communicated to matter at first. And I think it may be worth considering, whether, by this doctrine of theirs, the Cartesians do not more take upon them, than other philosophers, to

judge of God's designs. For, if a man be known to be very wise, and have various ways of compassing his several ends, he, that, seeing some of those ways have a direct tendency to some rational end, shall conclude that end to be one of those, that is intended, does thereby less presume, and express more respect to that wise man, than he, that should conclude, that those cannot be his ends, and that he can have no other design, knowable by us, except a certain general one named by the assertor. And indeed, it seems more easy to know, that this or that particular thing, for which an engine is proper, may be, among others, intended by the artificer, though never so skilful, than to know negatively, that he can have no other, than such or such an end.

AND how will a Cartesian assure me, that, among the many ends, that he grants that God may have proposed to Himself in the production of his mundane creatures, one may not be, that we, whom He has vouchsafed to make intelligent beings, and capable of admiring and praising Him, should find just cause to do so, for the wisdom and goodness He has displayed in the world? which attributes we could not well discern or celebrate, unless we knew as well, that the creatures were made for such uses, as that they are exceedingly well fitted for them. I know God's immutability is alledged, to prove, that the quantity of motion is never varied; but to me it is not evident, why God's having particular ends, though some of them seem to require a change in his way of acting in natural things, must be more inconsistent with his immutability, than his causing many things to be brought to pass, which though *ab æterno* he decreed to do, are yet not actually done, unless in process of time. And particularly it seems not clear, why God may not as well be immutable, though He should sometimes vary the quantity of motion, that He has put into the world, as He is, though, according to the opinion of most of the Cartesians themselves, He does daily create multitudes of rational souls, to unite them to human bodies; especially considering, that these newly created substances are, according to *Des Cartes*, endowed with a power to determine and regulate the motions of the spirits and the conation, which are things clearly corporeal. I say not this, as if I absolutely rejected the Cartesian doctrine, about the continuance of the same quantity of motion in the whole mass of matter; for, whether or no it be a truth, I think it no unuseful nor improbable hypothesis; and I have not so much argued against it, as upon the grounds on which they argue for it.

WHEREFORE, to come now to the thing itself, whereas monsieur *Des Cartes* objects, that it is a presumption for man to pretend to be able to investigate the ends, that the omniscient God proposed to Himself in the making of his creatures; I consider, by way of answer, that there are two very differing ways, wherein a man may pretend to know the ends of God in his visible works: for, he may either pretend to know only some of God's ends, in some of his works; or he may pretend to know all his ends. He, that arrogates to himself to discover God's ends in this latter sense, will scarce be excused from a high presumption, and no less a folly, from the reason lately intimated in the Cartesian objection. But to pretend to know God's ends in the former sense, is not a presumption, but rather to take notice of them is a duty. For there are some things in nature so curiously contrived, and so exquisitely fitted for certain operations and uses, that it seems little less than blindness in him, that acknowledges, with the Cartesians, a most wise Author of things, not to conclude, that, though they may have been designed for other (and perhaps higher) uses, yet they were designed for this use. As he, that sees the admirable fabric of the coats, humours, and muscles of the eyes, and how excellently all the parts are adapted to the making up of an organ of vision, can scarce forbear to believe, that the Author

of

of nature intended it should serve the animal to which it belongs, to see with. The Epicureans indeed, that believe the world to have been produced but by the casual concurrence of atoms, without the intervention of any intelligent being, may have a kind of excuse, whereof other philosophers are destitute, that acknowledge a Deity, if not also a Providence. For the very supposition, for instance, that a man's eyes were made by chance, argues, that they need have no relation to a designing agent; and the use, that a man makes of them, may be either casual too, or at least may be an effect of his knowledge, not of nature's. But when, upon the anatomical dissection, and the optical consideration, of a human eye, we see it is as exquisitely fitted to be an organ of sight, as the best artificer in the world could have framed a little engine, purposely and mainly designed for the use of seeing; it is very harsh and incongruous to say, that an artificer, who is too intelligent either to do things by chance, or to make a curious piece of workmanship, without knowing what uses it is fit for, should not design it for an use, to which it is most fit.

It is not to be denied, that He may have more uses for it than one, and perhaps such uses as we cannot divine: but this hinders not, but that, among its several uses, this, to which we see it so admirably adapted, should be thought one. And I see not, how it does magnify God's wisdom, or express our veneration of it, to exclude, out of the number of his ends in framing human eyes, that most obvious and ready use, which we are sure is made of them, and which they could not be better fitted for. This may perhaps be not unfitly illustrated by the following comparison, whereof the application were superfluous. Suppose that a countryman, being in a clear day brought into the garden of some famous mathematician, should see there one of those curious gnomonic instruments, that shew at once the place of the sun in the zodiac, his declination from the æquator, the day of the month, the length of the day, &c. It would indeed be presumption in him, being unacquainted both with the mathematical disciplines, and the several intentions of the artist, to pretend or think himself able to discover all the ends, for which so curious and elaborate a piece was framed: but when he sees it furnished with a style, with horary lines and numbers, and, in short, with all the requisites of a sun-dial, and manifestly perceives the shadow to mark, from time to time, the hour of the day, it would be no more a presumption than an error in him to conclude, that (whatever other uses the instrument is fit or was designed for) it is a sun-dial, that was meant to shew the hour of the day.

AND here I shall demand of those, that will not allow us to think, that any natural things are directed to ends knowable by men; whether, if the divine Author of them had really designed them for such ends, the things themselves are not so framed and directed, as in that case they should be? and whether the fabric and management of natural things do really countenance or contradict our supposition?

For my part, after what has been already discoursed, I scruple not to confess, that I see not, why it should be reputed a disparagement to the wisdom of any agent whatsoever, to think, that his productions were designed for such ends, among others, as they are excellently framed and fitted for; unless it did appear, that those ends were unworthy to be designed by the wise agent. But that cannot be justly said in our present case; since it is not injurious to the divine Author of things, to believe that some of the ends, to which He destined divers of his corporeal works, were, to exert and communicate his exuberant goodness, and to receive from his intelligent creatures, such as men, an ardent love, a high admiration, and an obsequious gratitude, for having displayed so much wisdom and beneficence, in exquisitely qualifying his works to be wonderfully serviceable to one another, and a great number of them to be particularly subservient to the necessities and utilities of man.

AND

AND indeed I can by no means assent to that assertion of *M. Des Cartes*, * That it cannot be said, that some of God's ends (in his corporeal works) are more manifest than others; but that all of them lie equally hid in the abyss of the divine Wisdom; since there are many of his creatures, some of whose uses are so manifest and obvious, that the generality of mankind, both philosophers and plebeians, have in all ages, and almost in all countries, taken notice of and acknowledged them. And as to what he adds, (by which he seems to intimate the motive that led him to make the forementioned assertion) that, in physics, all things ought to be made out by certain and solid reasons; to this I answer, first, that I see not, why the admitting, that the Author of things designed some of his works for these or those uses, amongst others, may not consist with the physical accounts of making of those things; as a man may give a mechanical reason of the structure of every wheel and other part of a watch, and of their way of acting upon one another, when they are rightly put together, and, in short, of the contrivance and phenomena of the little machine; though he suppose, that the artificer designed it to shew the hours of the day, and though he have that intended use in his eye, whilst he explicates the fabric and operations of the watch. I answer, secondly, that I readily admit, that in physics we should indeed ground all things upon as solid reasons as may be had; but I see no necessity, that those reasons should be always precisely physical; especially if we be treating, not of any particular phenomenon, that is produced according to the course of nature established in the world, already constituted as this of ours is; but of the first and general causes of the world itself; from which causes, I see not, why the final causes, or uses, that appear manifestly enough to have been designed, should be excluded. And to me it is not very material, whether or no, in physics, or any other discipline, a thing be proved by the peculiar principles of that science or discipline, provided it be firmly proved by the common grounds of reason. And on this occasion let me observe, that the fundamental tenets of *M. Des Cartes's* own philosophy are not by himself proved by arguments strictly physical, but either by metaphysical ones, or the more catholic dictates of reason, or the particular testimonies of experience. For when, for instance, he truly ascribes to God all the motion that is found in matter, and consequently all the variety of phenomena that occur in the world; he proves not, by an argument precisely physical, that God, who is an immaterial agent, is the efficient cause of motion in matter; but only by this, that, since motion does not belong to the essence and nature of matter, matter must owe the motion it has to some other being: and then it is most agreeable to common reason to infer, that since matter cannot move itself, but it must be moved by some other being, that being must be immaterial, since otherwise some matter must be able to move itself, contrary to the hypothesis. And when *Des Cartes* goes to demonstrate, that there is always in the universe the self-same quantity of motion, (that is, just as much at any one time, as at any other) and consequently, that as much motion as one body communicates to another, it loses itself; he proves it by the immutability of God, which is not a physical argument strictly so called, but rather a metaphysical one; as he formerly proved God's being the cause of all motion in matter, not by principles peculiar to physics, but by the common grounds of reason.

† THOUGH *Monsieur Des Cartes* does, as I have formerly shewn, speak very dogmatically and universally against men's endeavouring or pretending to know any final causes.

* *Nec fingi potest, aliquos Dei fines, magis quam alios, in propatulo esse; omnes enim in imperscrutabili ejus sapientiae abisso sunt eodem modo reconditi. Resp. Quart. ad object. Gassendi.*

† *C'est une chose, qui de soy est manifeste, que nous ne pouvons connoître les fins de Dieu, si luy mesme ne nous les revele. Et encore qu'il soit vray en morale, eu egard a nous autres hommes, qui toutes choses ont este faites pour la gloire.*

causes in natural things; for which reason I have, as well as the generality of his other readers, and even his disciples, looked upon the sense of those positive expressions, as containing his opinion; yet, since I writ the foregoing part of this treatise, I lighted on a passage of his, wherein he seems to speak more cautiously or reservedly, opposing his reasoning to their opinion, who teach, that God hath no other end, in making the world, but that of being praised by men. But in that short discourse, whereof this passage is a part, there are two or three other things, wherein I cannot acquiesce. As first, that it is self-evident, that we cannot know the ends of God, unless He Himself reveal them to us; (he must mean in a supernatural way, if he will not speak impertinently): for what he says to be evident of itself, is not at all so to the generality of mankind, and even of philosophers; and therefore, I think, it ought not to be barely pronounced, but (if it can be) should be proved. And next, he does not shew, how we are obliged to praise God for his works, if He had no intention to have us do so, or that we should discover any of the ends for which He made them. If a judicious man should see a great book, written in some Indian language, which he is utterly a stranger to, and should know nothing of it, but that it was made by a very intelligent physician; he might indeed conclude, that the work was not made by chance, but would have no means to be convinced, by the inspection of the book itself, that it was composed with great skill and kindness, and deserved his praise and thanks; since he could not know any of the particular ends, to which the several chapters of it were destinated, nor consequently discover how skilfully they were fitted to reach such ends. What *Des Cartes* says, that it is childish and absurd to think, that God had created the sun, which is many times bigger than the earth, only to afford light to man, who is but a small part of it, is somewhat invidiously proposed; there being few able writers, that confine the utility of the sun directly to the affording light to man; and the littleness of his bulk ought not to make it thought absurd, that God may have had an especial eye to his welfare, in framing that bright globe; since not only, for aught appears to us, that most excellent engine of man's body is a more admirable thing than the sun, but the rational and immortal soul, that resides in it, is incomparably more noble than a thousand masses of brute matter, and that not so much as organized, can be justly reputed, (as will be hereafter more fully declared.) And since, in this very discourse, the acute author of it confesses, that we may know the ends of God's corporeal works, if He reveal them to us; a Christian philosopher may be allowed to think the sun was made, among other purposes, to enlighten the earth, and for the use of man, since the scripture teaches us, that not only the sun and moon, but the stars of the firmament, which *Des Cartes* not improbably thinks to be so many suns, were made to give light to the earth, and were divided to all the nations that inhabit it. Perhaps it were not rash to add, that I see not, why the belief, that a man may know some of God's ends in things corporeal, should more derogate from our veneration of his wisdom, than to think we know some of his ends in other matters, of which the scripture furnishes us with a multitude of instances, as (particularly) that of *Job* sacrificing for his friends; and the declared uses of the *Urim* and *Thummim*: since God may, if He pleases, declare truths to men, and instruct them, by his creatures and his actions, as well as by his words: as when

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gloire de Dieu, a cause que les hommes sont obligez de louer Dieu pour tous ses ouvrages; Et qu'on puisse aussi dire, que le soleil a este fait pour nous eclaire, pour ce que nous experimentons, que le soleil en effet nous eclaire: ce seroit toutesfois une chose puerile Et absurde, d'assurer en metaphysique, que Dieu, a la fagon d'un homme superbe, n'auroit point eu d'autre fin en bastissant le monde, que celle d'estre loue par les hommes; et qu'il n'auroit cree le soleil, qui est plusieurs fois plus grand que la terre, a autre dessein, que d'eclairer l'homme, qui n'en occupe qu'une tres petite partie.

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He taught *Noah* by the rain-bow, and *Jonah* by a gourd and a worm, and regulated the incampment of the *Israelites* by the guidance of a cloud and a fiery pillar. Lastly, whereas *Monfieur des Cartes* objects, that those, he dissents from, talk, as if they looked upon God as a proud man, who designed his works only to be praised for them; I know not, whether in this place he speaks so cautiously and reverently of God as he ought, and elsewhere is wont to do. For as humility, though it be a virtue in men, is extremely remote from being any of God's perfections; so that may be pride in a man, who is but a creature, imperfect, dependent, and hath nothing that he has not received, which would be none at all in God, who is incapable of vice, and who may, if He please, justly propose to Himself his own glory for one of his ends, and both require and delight to be praised by men for his works; since He is most worthy of all praise, and it is their duty and reasonable service, which He is graciously pleased to approve of, to pay it Him.

It is not without trouble, that I find myself obliged, by the exigency of my design, so much to oppose, in several places of this present discourse, some sentiments of *M. Des Cartes*, for whom otherwise I have a great esteem, and from whom I am not forward to dissent: and this I the rather declare to you, because I am not at all of their mind, that think *M. Des Cartes* a favourer of atheism, which, to my apprehension, would subvert the very foundation of those tenets of mechanical philosophy that are particularly his. But judging, that his doctrine (at least as it is understood by several of his followers, as well as his adversaries) about the rejection of final causes from the consideration of naturalists, tends much to weaken (as is elsewhere noted) if not quite to deprive us of one of the best and most successful arguments to convince men that there is a God, and that they ought to admire, praise, and thank Him; I think it my duty to prefer an important truth before my respect to any man, how eminent soever, that opposes it, and to consider more the glory of the great Author of nature, than the reputation of any one of her interpreters.

AND to strengthen what I have been saying, give me leave to mind you more expressly here of what I have elsewhere intimated, *viz.* that the excellent contrivance of the great system of the world, and especially the curious fabric of the bodies of animals, and the uses of their sensories, and other parts, have been made the great motives, that in all ages and nations induced philosophers to acknowledge a Deity, as the author of these admirable structures; and that the noblest and most intelligent praises, that have been paid Him by the priests of nature, have been occasioned and indited by the transcending admiration, which the attentive contemplation of the fabric of the universe, and of the curious structures of living creatures, justly produced in them. And therefore it seems injurious to God, as well as unwarrantable in itself, to banish from natural philosophy the consideration of final causes; from which chiefly, if not only, I cannot but think (though some learned men do otherwise) that God must reap the honour, that is due to those glorious attributes, his wisdom, and his goodness. And I confess I sometimes wonder, that the Cartesians, who have generally, and some of them skilfully, maintained the existence of a Deity, should endeavour to make men throw away an argument, which the experience of all ages shews to have been the most successful (and in some cases the only prevalent one) to establish, among philosophers, the belief and veneration of God. I know the *Cartesians* say, that their master has demonstrated the existence of a God, by the innate idea, that men have of a being infinitely perfect, who left it upon the mind of man, as the mark of an artist impress upon his work: and also, that they ascribe to God the having made matter out of nothing, and alone put it into motion; which sufficiently argue the immensity of his power. But though I would by no means weaken the argu-

ment drawn from the inbred notion of God, since I know, that divers learned men have acquiesced in it; yet, on the other side, I see not, why we may not reasonably think, that God, who, as themselves confess, has been pleased to take care men should acknowledge Him, may also have provided for the securing of a truth of so great consequence, by stamping characters, or living impresses, that men may know his wisdom and goodness by, as well without, upon the world, as within, upon the mind. The bare speculation of the fabric of the world, without considering any part of it, as destinated to certain (or determinate) uses, may still leave men unconvinced, that there is any intelligent, wise, and provident Author and Disposer of things; since we see generally the *Aristotelians* (before some of them were better instructed by the Christian religion) did, notwithstanding the extent, symmetry, and beauty of the world, believe it to have been eternal. And though they, whatever their master thought, did not believe it to have been created by God; yet, because they asserted, that animals, plants, &c. act for ends, they were obliged to acknowledge a provident and powerful being, that maintained and governed the universe, which they called nature; though they too often dangerously mistook, by sometimes confounding this being with God himself, and at other times speaking of it as co-ordinate with Him, as in that famous axiom of *Aristotle*, *Deus & natura nihil faciunt frustra*. I acknowledge therefore, that, as I set a just value upon the *Cartesian* proof of God's existence, so I see no reason, why we should disfurnish ourselves of any other strong argument to prove so noble and important a truth; especially, since the *Cartesian* way of considering the world is very proper indeed to shew the greatness of God's power, but not, like the way I plead for, to manifest that of his wisdom and beneficence. For, whereas a *Cartesian* does but shew, that God is admirably wise, upon the supposition of his existence; in our way the same thing is manifested by the effect of a wisdom, as well as power, that cannot reasonably be ascribed to any other than a most intelligent and potent Being: so that by this way men may be brought, upon the same account, both to acknowledge God, to admire Him, and to thank Him.

S E C T. II.

TO give you now my thoughts of the second question, viz. *Whether we may consider final causes in all sorts of bodies, or only in some peculiarly qualified ones*; I must divide natural bodies into animate or inanimate. The former of which terms I here take in the larger sense of those, who under it comprehend, not only animals, but vegetables; though I shall not disdainfully reject the opinion of those learned men, that are unwilling to allow plants a soul or life, at least as properly so called as that which is confessedly granted to animals.

Of the inanimate bodies of the universe, the noblest, and those, which, on this occasion, deserve chiefly to be considered, are the sun, planets, and other celestial bodies. For, when men saw those vast and luminous globes, and especially the sun, move so constantly, and so regularly, about the earth, and diffuse on it light and heat; and by their various revolutions produce day and night, summer and winter, and the vicissitudes of seasons, that are so opportune for the inhabitants of the earth: the observers, I say, of all this concluded, both that these motions were guided by some divine Being, and that they were designed for the benefit of man. Whether this be a demonstrative conclusion, I shall not now debate; but I see not, why it may not have thus much of probability in it, that in case a man shall think, that the fabric of the celestial parts of the world was the curious production of an intelligent and

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divine Agent, the regular phænomena of the heavens will not contradict him; since there is nothing in that fabric that misbecomes a divine Author; and the motions and operations of the sun and stars are not such, but that they will allow us to think, that, among other purposes, they were made to illuminate the terrestrial globe, and bring heat and other benefits to the inhabitants of it: so that the contemplation of the heavens, which so manifestly *declare the glory of God*, may justly excite men, both to Pl. xix. 1. admire his power and wisdom in them, and to return Him thanks and praises for the great benefits, that accrue to us by them.

BUT now, on the other side, it may be said, that in bodies inanimate, whether the portions of matter they consist of be greater or lesser, the contrivance is very rarely so exquisite, but that the various motions and occurrences of the parts of matter may be, without much improbability, suspected to be capable, after many essays, to cast one another into divers of those circumvolutions of matter, that, I remember, *Epicurus* calls *συρροφάς*, and *Des Cartes* *vortices*; which, being once made, may continue very long, by the means expressed by *Cartesius*, or by some other as probable ones. But, without allowing this hypothesis to be more than not very improbable, when I consider, what causes there may be to fear, that we are not yet sufficiently acquainted with the true system of the world, and are not usually sensible enough, how small a part we, and the terrestrial globe we inhabit, make of the universe; I am apt to fear too, that men are wont, with greater confidence than evidence, to assign the systematical ends and uses of the celestial bodies, and to conclude them to be made and moved only for the service of the earth and its inhabitants. And though, even as a meer naturalist, I will not deny, that, as man actually receives benefits by the established order and motion of the stars, so one of the several uses intended by the Author of nature in them may particularly respect men; yet I am apt to think, that, by what we hitherto know, it will not be easy to be proved, that some, at least, of the celestial bodies and motions may not be intended more for other purposes, than to cast their beams, or shed their influences (supposing they have some) upon the earth. And, at least, I cannot but think, that the situations of the celestial bodies do not afford by far so clear and cogent arguments of the wisdom and design of the Author of the world, as do the bodies of animals and plants. And, for my part, I am apt to think, there is more of admirable contrivance in a man's muscles, than in (what we yet know of) the celestial orbs; and that the eye of a fly is (at least as far as appears to us) a more curious piece of workmanship than the body of the sun.

As for other inanimate bodies, as stones, metals, &c. whose matter seems not organized, though there be no absurdity to think, that they were made for distinct particular purposes, if not also for human uses; yet most of them are of such easy and unelaborate contextures, that it seems not absurd to think, that various occurrences and justlings of the parts of the universal matter may at one time or other have produced them; since we see in some chymical sublimations, and cristallizations of mineral and metalline solutions, and some other phænomena, where the motions appear not to be particularly guided and directed by an intelligent cause, that bodies of as various contextures, as those are wont to be, may be produced; of which I have elsewhere given some instances.

If it be objected, that if we allow chance, or any thing else, without the particular guidance of a wise and all-disposing Cause, to make a finely shaped stone, or a metalline substance, growing, as I have sometimes seen silver to do, in the form of a plant, it ought not to be denied, that chance may also make vegetables and animals; I can by no means allow the consequence. There are some effects, that are so easy, and

so ready to be produced, that they do not infer any knowledge or intention in their causes; but there are others, that require such a number and concurrence of conspiring causes, and such a continued series of motions or operations, that it is utterly improbable they should be produced without the superintendency of a rational Agent, wise and powerful enough to range and dispose the several intervening agents and instruments, after the manner requisite to the production of such a remote effect. And therefore it will not follow, that if chance could produce a slight contexture in a few parts of matter, we may safely conclude it able to produce so exquisite and admirable a contrivance as that of the body of an animal. What then, if sometimes in sawing pieces of variegated marble, men happen, though rarely, to meet with the delineations or pictures (some of which I have beheld with pleasure) of towns, woods, and men? for, besides that the pleasingness and rarity of such spectacles inclines the imagination to favour them, and supply their defects; would any wise man therefore conclude, that a real town or wood, much less numbers of men, should be made by such a fortuitous concurrence of matter? What comparison is there betwixt the workmanship, that seems to be expressed in a few irregular lines drawn upon a plane superficies, and perhaps two or three colours luckily placed, and the great multitude of nerves, veins, arteries, ligaments, tendons, membranes, bones, glandules, &c. that are required to the completing of a human body; of which numerous parts (for the bones alone are reckoned to amount to three hundred) every one must have its determinate size, figure, consistence, situation, connexion, &c. and many, or all of them together, must conspire to such and such determinate functions or uses? And indeed, though I keep by me some curious ones, yet I never saw any inanimate production of nature, or, as they speak, of chance, whose contrivance was comparable to that of the meanest limb of the despicablest animal: and there is incomparably more art expressed in the structure of a dog's foot, than in that of the famous clock at *Straßburg*.

AND though the paw of a dog will be confessed to be of a structure far inferior to that of the hand of a man; yet even this, however *Aristotle* prettily styles it the instrument of instruments, is a less considerable instance to my present purpose, than another instance, which therefore, since my intended brevity permits me not to consider many, I shall pitch upon, as that, which I shall almost only insist on in the following part of this tract: and this instance is afforded me by the eye. For though the parts, that concur to make up that admirable organ of vision, are very numerous, yet how little any of them could have been spared or altered, unless for the worse, may appear by that great number of diseases, that have been observed in that little part of the body: since each of those diseases consist in this, that some of the coats, humours, or other parts of the eye, are brought into a state differing from that, whereto nature had designed it, and whereinto she had put it. It would be tedious so much as to enumerate the several distempers of the eye, whereunto physicians have given particular names; wherefore I shall only mention two or three things, wherein one would scarce imagine, that a small recess from the natural state could bring any considerable, or perhaps sensible, inconvenience. That, which we call the pupil, is not (you know) a substantial part of the eye, but only a hole of the uvea; which aperture is almost perpetually changing its bigness, according to the differing degrees of light that the eye chances from time to time to be exposed to: and therefore one would not think, but that, whilst this hole remains open, it performs well enough its part, which is, to give admission to the incident beams of light, whether direct or reflected. And yet I lately saw and discoursed with a woman, who, after a fever, was not able to dilate the pupils of her eyes as formerly; and
though

though they were so very little narrower than ordinary, that I should scarce have taken any notice that it was at all so, if she had not told me of it, yet she complained she had thereby almost lost her sight, seeing objects in certain lights but very dimly and imperfectly. And though the præternatural constriction of the pupil be not a frequent distemper, yet it is not so rare, but that physicians have given it a place among the stated diseases of the eye. And, on the other side, though it appear by what hath been newly related, that a competent wideness of the pupil is requisite to clear and distinct vision, yet, if its wideness exceed due limits, there is produced that distemper called *dilatatio pupillæ*; which is worse than the former, because it oftentimes deprives the patient almost totally of his sight. And though it may seem but a slight circumstance, that the transparent coats of the eye should be devoid of colour, and of as little moment, that the *cornea* should be very smooth, provided it be transparent; yet, when either of these circumstances is wanting, the sight may be much vitiated: as we see, that in the yellow-jaundice, when it is come to a high degree, the adventitious tincture, wherewith the eye is imbued, makes men think they see a yellowness in many objects, to which that colour does not belong. And I know an ingenious gentleman, who having had a small *pustula* excited and broken upon the *cornea*, though the eye have been long whole; yet a very little inequality or depression, that still remains upon the surface of the transparent *cornea*, does so affect him, that, though he can read well in a room, yet, when he comes into the open fields or the streets, he for a pretty while (as himself has particularly complained to me) thinks many of the objects he looks on very glaring, and sees many others, as men do stones at the bottom of a brook or running water; which I impute to the want of uniformity in the refraction of those reflected beams of light that fall upon the *cornea*, whose surface is not so smooth and equal as it should be.

To give some further proof, that the eye was made with design, I shall here take notice of an observation or two, that do not occur in the dissection of a human eye, and therefore are not wont to be mentioned by anatomists.

I HAVE observed in frogs (as I presume some others also may have done) that, besides those parts of the eye, which they have in common with men, dogs, cats, and the most part of other animals, they have a peculiar, whether membrane or cartilage, or both, which ordinarily is not perceived, wherewith they can at pleasure cover the eye, without too much hindering the sight, because this membrane is as well transparent as strong; so that it may pass for a kind of moveable *cornea*, and (if I may so call it) a kind of false-scabbard to the eye. In furnishing frogs with this strong membrane, the providence of nature seems to be conspicuous: for they being amphibious animals, designed to pass their lives in watery places, which for the most part abound with sedges, and other plants endowed with sharp edges or points, and the progressive motion of this animal being to be made, not by walking, but by leaping; if his eyes were not provided of such a sheath as I have been mentioning, he must either shut his eyes, and so leap blindly, and by consequence dangerously, or, by leaving them open, must run a venture to have the *cornea* cut, prickt, or otherwise offended, by the edges or points of the plants, or what may fall from them upon the animal's eyes: whereas this membrane, as was said, is like a kind of spectacle, that covers the eye without taking away the sight; and as soon as the need of employing it is past, the animal at pleasure withdraws it into a little cell, where it rests out of the way, till there be occasion to use it again. This you may see, if you apply the point of a pin, or a pen, or any such sharp thing, to the eye of a frog, whilst you hold his head steady: for, to screen his eye, he will presently cover it (at least for the greatest part) with this membrane, which, when the danger is over,

he will again withdraw. And because many, if not most sorts of birds are wont or destinated to fly (as more would do if not kept tame) among the branches of trees and bushes; lest the prickles, twigs, leaves, or other parts, should wound or offend their eye, nature hath given them such another kind of horny membrane, as we have been mentioning in frogs.

It is known, that men, and the generality of four-footed beasts, and of birds, have several muscles belonging to their eyes; by the help of which muscles they can turn them this way, or that way, at pleasure; and so can obvert the organ of sense to the object, whether it be placed on the right hand or the left, or above or beneath the eye. But nature having not given that mobility to the eyes of flies, (the reason whereof I shall not now stay to consider) she hath in recompense furnished them with a multitude of little protuberant parts, finely ranged upon the convex of their large and protuberant eyes: so that by the means of the number of these little studs (if I may so call them) many beams of light, that rebound from objects placed on either hand, or above, or beneath, the level of the eye, fall conveniently enough upon that organ, to make the objects they come from visible to the animal; which you will the more easily believe, if you contemplate (as I have often done with great pleasure) even the eye of an ordinary flesh-fly, (for bees and other greater insects have immoveable eyes too, but I find them not so pretty) in a good microscope and a clear day; for you may reckon some hundreds of these little round protuberances curiously ranged on the convexity of a single eye.

But perhaps some, whose partiality for chance makes them willing to ascribe the structures of animals rather to that, than to a designing cause, will make them draw an objection, fit here to be obviated, against our doctrine, from what we have observed of the difference between human and other eyes; since they will pretend, that all organs of sight ought to be conformed to those of men, as those that are the best and most perfect. It is true, that man being justly reputed the most perfect of animals, it is not strange that he should (as men generally do) presume, that his eyes and other parts of his body are the best contrived of any, that are to be found in nature. But yet I think we cannot from hence safely conclude, that all eyes, which in other animals are of structures differing from those of man, are for that reason defective. For I consider, first, that the admirable wisdom displayed by the Author of things, in fitting the eyes, and other organical parts of animals, for the uses that seem manifestly to have been designed in their fabric, and for the respective functions we actually see them exercise, may justly persuade us, that the things, whose reasons or uses we do not alike discern, are yet most wisely constituted; such an author as God having too much knowledge to do any thing unskilfully, and we having too much presumption, if we think He can have, in the framing of his creatures, no ends that are beyond our discovery. And, secondly, we may represent, that the eye is not to be considered abstractedly as an instrument of vision, but as an instrument belonging to an animal of this or that kind, and who is ordinarily to make use of it in such and such circumstances. And therefore I think it ought not at all to disparage, but rather highly recommend, the wisdom and providence of the great Author of things, that He has furnished various species of animals with organs of sight, that are very differently framed and placed; since this diversity notably manifests his great providence, and (if I may so call it) forecast, that has admirably suited the eyes of the differing kinds of animals both to the rest of their bodies, and (which I here mainly consider) to those parts of the great theatre of the world, on which He designs that they shall live and act. Thus, though divers beasts, as horses, oxen, and some others, have their eyes furnished with a seventh muscle, besides the six

fix they have in common with men; we must not conclude, either that the organs of vision are imperfect in men, or that those of these beasts have something superfluous. For horses, &c. being to feed for the most part on grass and herbs of the field, and, that they may the better chuse their food, being obliged to make their eyes look very long downwards; the seventh muscle does excellently serve them to do so, without that weariness, which, if they were not furnished with it, that durably constrained posture would be sure to give them; whereas man, who has no such necessity of looking assiduously downwards, would be but incumbered by a seventh muscle.

On the other side, the defectiveness observable in the eyes of some animals, in comparison of those of man, may be ascribed to the thriftiness (if I may so speak) of nature, that, on most occasions, declines doing that, which is not necessary to the particular ends she aims at in the fabric of a part. Thus moles being designed to live for the most part under ground, the eyes, which nature hath given them, are so little, in proportion to their bodies, that it is commonly believed, and even by some learned men maintained, they have none at all. But though by anatomy, I, as well as some others, that have tried, have found the contrary; yet their eyes are very differing from those of other four-footed beasts. Which is not to be wondered at, considering, that the design of nature was, that moles should live under ground, where a sight was needless and useless, and where greater eyes would be more exposed to danger; and their sight, as dim as it is, is sufficient to make them perceive, that they are no longer under ground, (at least so as they are wont to be) which seems to be the most necessary use they have of light and eyes.

ZOOGRAPHERS observe, that theameleon has a very uncommon structure of his visive organs; since, to omit lesser, though not inconsiderable, peculiarities, his eyes often move independently from one another; so that, for instance, he may look directly forward with the right eye, and with the other at the same time directly backwards towards his tail; or may turn the pupil of the former straight upwards, whilst he looks downwards with the other: which peculiar power seems to have been granted him by Providence, that, being a very slow animal, and destinated to live for the most part in trees and bushes, and there chiefly feed on flies, he may perceive them, which way soever they chance to come within the reach of his long tongue, by suddenly darting out of which he catches his nimble prey.

WHEREAS it may be observed, that many or most, if not all, meer fishes have the chrystalline humours of their eyes almost spherical, as to sense, and consequently far more round than that humour is wont to be found in man, and other terrestrial animals; this difference of figure, though it would be inconvenient to us, does very well accommodate fishes; since they living in the water, which, as a thicker medium, does much more refract the beams of light, than the air, through which they pass to our eyes, it was fit, that the chrystalline humour of fishes should be very globous, that, by the help of their figure, the beams, already refracted by the water, should be yet so much refracted and made convergent, as to paint the images so near as upon the bottom of the eye.

ONE, that, being curious, had more opportunity, than I have, to survey and reflect on the various structures of the organs of vision in differing animals, may, if I mistake not, be able to find, by comparing them with the other parts of the same animal, and the scene he is designed to act on, and the uses he is to make of his eyes in his most ordinary circumstances; such a person, I say, may be able to offer a probable reason of several differences in those organs, that, if commonly taken notice of, would seem to the censorious to be aberrations of nature, or defects.

defects. To which purpose I remember, that an ingenious cultivator of optics gives this reason of what both he and I have taken notice of (though it be usually overlooked) about the figure of the pupil; namely, that though it be oblong in horses, oxen, and divers other quadrupeds, as well as in cats, yet in the former kinds of animals the pupil lies transversely from the right side of the eye to the left, but in cats its situation is perpendicular; whereof he ingeniously guesses the reason may be, that horses and oxen being usually to find their food growing on the ground, they can more conveniently receive the images of the laterally neighbouring grass, &c. by having their pupils transversely placed; whereas cats, being to live chiefly upon rats and mice, which are animals, that usually climb up or run down walls and other steep places, the commodiousest situation of their pupil, for readily discovering and following these objects, was to be perpendicular. But it is time we proceed in our discourse.

OTHER instances to the same purpose with this are elsewhere delivered; and therefore I shall now, to strengthen the apology for Divine Providence, take notice, that the differing structures and situations of the eyes in several animals are very fit to shew the fecundity of the divine Author's skill, (if I may so speak) in being able to frame so great a variety of exquisite instruments of vision. And indeed, if I may presume to guess at any of God's ends, that are not manifest, (for other of his ends seem conspicuous) I should think, that this delightful and wonderful variety, that we may observe, not only in animals themselves considered as entire systems, but in those parts of them, that appear destinated for the same function, as particularly that of seeing was designed, at least among other ends, to display the multiplicity of the great Creator's wisdom, and shew his intelligent creatures, that his skill is not confined to one sort of living engines, nor in the parts of the same kind (as eyes, ears, teeth, &c.) to the same contrivances; but is able to make, for the same use, a multitude of surprising organs or instruments, though not perhaps all equally perfect, (since, to do so, we may think He must make no animals but men) yet all of them curious and exquisite in their kinds, and in order to their differing ends. To be able to frame both clocks and watches, and ships, and rockets, and granadoes, and pumps, and mills, &c. argues and manifests a far greater skill in an artificer, than he could display in making but one of those sorts of engines, how artificially soever he contrived it. And the same superiority of knowledge would be displayed, by contriving engines of the same kind, or for the same purposes, after very differing manners. As weights indeed are of great use and necessity in the famous clock of *Straßburg*; and therefore it recommends the inventors of watches, not only that they can make clocks of a very little and easily portable bulk, which the *Straßburg* machine is not, but can make a clock without weights, and by means of a spring perform their office. And thus, though to fly it seems absolutely necessary that an animal should be furnished with feathers, the wise Creator hath shewn, that He is not confined to make use of them for that purpose; since a flying fish is able to move a great way in the air; and the Indies have lately furnished us with a sort of flying squirrels, whereof I saw one alive at *Whitehall*. And though the flight of these is not long, yet there is another kind of animals without feathers, that can fly long enough, namely, the bat; though some of these, as I have seen, be little less than hens: and I have been assured by a credible eye-witness, that in the kingdom of Golconda he had seen much bigger.

BUT though this consideration may suffice to justify the wisdom of the Creator, who being an agent most free, as well as most wise, men ought not to find fault, if He think fit to recommend his wisdom by displaying it in very different manners, yet this is not all that may be said on this occasion. For there are many cases, and perhaps

perhaps far more than we imagine, wherein the peculiar, and in some regards less perfect, fabric or situation of an eye or other organical part, may be more convenient, than the correspondent organ of man, to attain the ends, for which it was given to an animal, that was to act upon such a theatre, and live by such provision. Besides that an organical part may, in some animals, be intended for more uses than in others, and therefore may require a differing structure, as in moles, the feet are otherwise framed or situated, than in other quadrupeds, because the chief use they were to make of them was not to walk upon the ground, but to dig themselves ways under ground; the provident *Δημιουργός* wisely suiting the fabric of the parts to the uses, that were to be made of them: as a mechanic employs another contrivance of his wheels, pinions, &c. when he is to grind corn with a mill, that is to be driven by water, than when he is to do the same thing by a mill, that is to be moved by the wind. And the camelion has a tongue, both peculiarly shaped, and of a length disproportionate to that of his body, because he was to take his prey by shooting out (if I may so speak) his tongue at the flies he was to live upon, and could not often approach them very near without frightening them away. And in many cases, in which this reflection does not so properly take place, we may observe, that there is a wonderful compensation made for that, which seems a defect in the parts of an animal of this or that particular species, compared with the correspondent ones of a man, or an animal of some other species.

Thus birds, that (except the batt, and one or two more) want teeth to chew their food, are not only furnished with hard bills to break it; and birds of prey, as hawks, &c. with crooked ones to tear it; but, which is more considerable, have crops to prepare and soften it, and very strong muscular stomachs to digest and grind it: in which work they are usually helped by gravel and little stones, that they are led by instinct to swallow, and which are often found (and sometimes in amazing numbers) in their stomachs, where they may prove a vicarious kind of teeth.

I SHALL hereafter have occasion to say somewhat more against their opinion, that find fault with those animated structures, that we think to be productions of the divine wisdom, under pretence, that the parts of some living creatures are not so curious and symmetrical, as not to have been casually producible. But, in the mean time, I shall here note, for those that ascribe so much to chance, that chance is really no natural cause or agent, but a creature of man's intellect. For the things, that are done in the corporeal world, are really done by the parts of the universal matter, acting and suffering according to the laws of motion established by the Author of nature. But we men, looking upon some of these parts as directed in their motions by God, or at least by nature, and disposed to the attainment of certain ends; if by the intervention of other causes, that we are not aware of, an effect be produced very differing from that, which we supposed was intended, we say, that such an effect was produced by chance. So that chance is indeed but a notion of ours, and such a thing, as a schoolman might call an extrinsical denomination, and signifies but this; that in our apprehensions the physical causes of an effect did not intend the production of what they nevertheless produced. And therefore I wonder not, that the philosophers, that preceded *Aristotle*, should not treat of chance, among natural causes; as we may learn from *Aristotle* himself, who is more just to them in suspecting they owned not such a cause, than in taxing them of an omission for not having treated of it.

AND on this occasion I shall only add, before I proceed, that whereas some of the most curiously shaped kind of stones, as the *Astroites*, have emboldened many of the favourers of *Epicurus* to bring them into competition with these animals, or parts of

animals, from their likeness to which they have received their names; it is fit to be considered, first, that some learned men have of late made it very probable, that some of the curiousest sorts of these stones were once really the animals whose shapes they bear, or those parts of animals which they resemble; which animal substances were afterwards turned into stones, by the supervening of some petrescent matter, or petrifying cause; of which metamorphosis I have met with, and do elsewhere mention, more instances than are fit to be so much as named in this place. Secondly, though some of those sorts of stones were the production of the mineral kingdom, (for I will not be dogmatical in this point); yet, besides that it would not clearly follow, that they owe their shapes to chance, since there is no absurdity to admit seminal principles in some more elaborate sorts of fossils; I think it would be very injurious to make these productions vie with the animals, to which they are compared. For the resemblance of shapes, wherein alone they and the animals agree, being but the outward figure, is but a superficial thing, and not worthy to be mentioned, in comparison of that wherein they differ; the rude and slight contexture of the best shaped stones, being incomparably inferior to the internal contrivance of an animal, which must consist of a multitude of parts, of such a figure, bulk, texture, situation, &c. as cannot but be obvious to any, that have seen dissections skilfully made. And it is not only in the stable and quiescent parts, that this great internal difference, between stones and the animals they resemble, is to be found; but there is in a living animal a greater difference, than any of the knives of anatomists can shew us in a dead one betwixt a stone, though never so curiously figured, and an animal. For there are, I know not how many, liquors, spirits, digestions, secretions, coagulations, and motions of the whole body, and of the limbs and other parts, which are lodged and performed in a living body, and not in a cadaver; and are perchance far more admirable, even than the structure of the stable and quiescent parts themselves. So that though a stone, outwardly very like a shell-fish, were made by chance; yet from thence to conclude, that chance may make a real living shell-fish, would be to argue worse than he, that should contend, that because even an unskilful smith may make a hollow piece of metal like a watch-case, though he can fill it but with filings of iron, or some other rude stuff, he must be able to make a watch; there being less difference betwixt the skill expressed in making the case of a watch and the movement, than in making a body like a shell, and the internal parts of a real fish: or to say, that because putrefaction and winds have sometimes made trees hollow, and blown them down into the water, where they swim like boats; therefore the like causes may make a galley, built and contrived, as well within as without, according to the laws of naval architecture, and furnished with mariners to row it, steer it, and, in a word, to excite and guide all its motions to the best advantage, for the preservation and various uses of the vessel. In short, if chance sometimes does some strange things, it is in reference to what she herself, but not to what nature, uses to perform.

AND NOW, to give you the summary of my thoughts, about the second question;
 1. I think, that from the ends and uses of the parts of living bodies the naturalist may draw arguments, provided he do it with due cautions, of which I shall speak under the fourth question. 2. That the inanimate bodies here below, that proceed not from seminal principles, have but a more parable texture, (if I may so speak) as earths, liquors, flints, pebbles, and will not easily warrant ratiocinations drawn from their supposed ends. 3. I think the cœlestial bodies do abundantly declare God's power and greatness, by the immensity of their bulk, and (if the earth stand still) the celerity of their motions, and also argue his wisdom and general providence

as to them; because he has for so many ages kept so many vast vortices, or other masses of matter, in scarce conceivably rapid motions, without destroying one another, or losing their regularity. And I see no absurdity in supposing, that, among other uses of the sun, and of the stars, the service of man might be intended; but yet I doubt, whether, from the bare contemplation of the heavens, and their motions, it may be cogently inferred, at least so strongly as final causes may be from the structure of animals, that either the sole or the chief end of them all is to enlighten the earth, and bring benefits to the creatures that live upon it.

IN what has been hitherto said on our second question, it is plain, that I suppose the naturalist to discourse merely upon physical grounds. But, if the revelations contained in the holy scriptures be admitted, we may rationally believe more, and speak less hesitantly, of the ends of God, than bare philosophy will warrant us to do. For if God is pleased to declare to us any thing concerning his intentions, in the making of his creatures, we ought to believe it, though the consideration of the things themselves did not give us the least suspicion of it; which yet in our case they do. And therefore a late ingenious author did causelessly reflect upon me, for having mentioned the enlightning of the earth, and the service of men, among the ends of God, which he thought undiscoverable by us. For whether or no we can discover them by meer reason, as divers of the heathen philosophers thought they did; yet sure we may know those, that God is pleased to reveal to us: and the persons I argued with were apparently such, as admitted the authority of the scriptures; which expressly teach us, that God made *the two great luminaries*, (for so I should render Gen. i. 16. the Hebrew words *אֶת־שְׁנֵי הַמְּדָאֲרֹת הָעֶדְלֹם*) *the greater for the rule of the day, and the lesser for the rule of the night*. And that *he made the stars also*, and set them in the firmament, or rather expansum of the heaven, *to give light upon the earth*. And a little above, among the uses of the luminaries these are reckoned, *to divide the day from the night, and to be for signs, and for seasons, and for days and years*. And in another place, the prophet *Moses*, dehorting the Israelites from worshipping the sun, the moon, and the stars, tells them, that *the Lord had imparted them unto all nations under the whole heaven*. And therefore those Cartesians, that, being di- Deut. iv. vines, admit the authority of holy scripture, should not reject the consideration of such final causes, as revelation discovers to us; since it is certainly no presumption to think we know God's ends, when He Himself acquaints us with them; nor to believe that the sun, though it be generally esteemed to be a nobler body than the terrestrial globe, was made, among other purposes, to give light to its inhabitants. It is recorded in the book of *Genesis*, the design of God in making man was, Gen. i. 26, that *men should subdue the earth* (as vast a globe as it is) *and have dominion over the fish* 27, 28. *of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and (to speak summarily) over every living thing, that moveth upon the earth*. And the same book informs us, that, after the deluge, God *delivered all terrestrial* Gen. ix. *beasts, and fowl, and fishes, and every moving thing, that lives*, into the hands of men; 23. and intended, that they should eat animals, as before the flood he had appointed them all the sorts of wholesome vegetables for their food. And since God was pleased to appoint, that men should live on these creatures, it cannot be absurd to say, that, among other purposes, to which He destinated the sun, his shining upon the earth was one; since, without his light and heat, men could not provide for or enjoy themselves; and neither those plants, that men and cattle must live upon, could grow and ripen; nor (consequently) those animals, that were to be their principal food and serve them for many other uses, could be sustained and provided for. Many other texts, that shew, how much God was pleased to intend man's welfare, and

dominion over many of his fellow-creatures, might be here alledged. But I shall content myself to mention what the kingly prophet says in the eighth psalm, where, *Pf. viii. 5, 6.* speaking of man to his Maker, he says: *Thou hast made him a little lower than the angels, and hast crowned him with glory and honour. Thou madest him to have dominion over the works of thine hands, and hast put all things under his feet.* Indeed if in man we consider only that visible part, his body; the smallness of it may make it thought improbable, that portions of the universe incomparably greater than he, should be at all intended to be serviceable to him. But Christians ought not to think this incredible, if they consider man, as he chiefly consists of a rational mind, which proceeds immediately from God, and is capable of knowing Him, loving Him, and being eternally happy with Him. They, that despise man considered in this capacity, do very little know the worth of a rational soul; and estimate things like masons, and not like jewellers, who justly value a diamond no bigger than a bean, more than a whole quarry of ordinary stones. And particularly to those undervaluers of their own species, that are divines, it may be represented, that God, who will not be denied to be the best judge in this case, as in all others, was pleased to consider men so much, as to give *David* cause to admire it in the words lately cited; and not only to endow them with his image at their first creation, but, when they had criminally lost and forfeited it, He vouchsafed to redeem them by no less than the sufferings and death of his own Son, who is incomparably more excellent than the whole world. And it is not incredible, that God should have intended, that many of his other works should be serviceable to man; since by miraculous operations He hath sometimes suspended the laws of nature, and sometimes overruled them, upon the account of man: as may appear by *Noah's* flood; by the passage of the *Israelites* on dry land through the Red Sea, and the river of *Jordan*; by the standing still of the sun and moon (or the terrestrial globe) at *Josbua's* command; by the inefficacy of the burning fiery furnace on *Daniel's* three companions; and (to be short) by the stupendous eclipse of the sun at the full moon, at the crucifixion of the *Messias*. To which I might add, that the chief part of mankind, namely the children of God, will, by their most bountiful Remunerator, be thought fit to inhabit the new world (for that, by an Hebraism, is meant by *the new heavens* *2 Pet. iii. 10, 11, 12,* and *the new earth* St. Peter speaks of) which shall succeed the renovation and refinement of the present world by the last fire, that will not only dissolve, but, if I may so speak, transfigure it. *13.*

AND we shall the less scruple to admit, that such vast and bright bodies as the sun and moon may be designed (among other things) to be serviceable to men, if we consider, that it is so far from being a constant rule, that a thing more excellent cannot (by a wise agent) be employed for the good of one that is less so, that not only the first angel, whose apparition we read of in the scripture, was sent to relieve *Hagar*, *Gen. xvi. 9, &c.* a slave wandering in a wilderness; another had regard to the life of a soothsayer's ass; *Num. xxii. 23.* and many others (and sometimes companies of them) were employed on earth to do good offices to particular persons: but of all the angels in general, the excellent epistle to the *Hebrews* informs us, That they are *ministring spirits, sent forth to minister unto them, who shall be heirs of salvation.* *Heb. i. 14.*

S E C T. III.

TO handle the third question*, it will be necessary for us to clear the grand difficulty, that has, ever since *Aristotle's* time, and even before that, perplexed

* Viz. Whether, and in what sense, the acting for ends may be ascribed to an unintelligent (and even inanimate) body.

those, that allow, in natural philosophy, the consideration of final causes. The difficulty is obvious enough; for much the greater part of bodies being void of knowledge, and most of them (as all inanimate bodies) of life itself, it seems not conceivable, how they should act constantly for ends they are not capable of pre-designing, and appositely employ means, that they have no knowledge, wherewith to make choice of.

ARISTOTLE, who expressly teaches, that nature does nothing in vain, and rightly judged, that the actions of natural agents tended to certain ends, takes notice of this difficulty, but seems rather to shift it off than resolve it; the solution he frames regarding so peculiarly the words, wherein he has expressed the objection, that I much doubt whether it would signify much to clear the same difficulty proposed in other terms: and to me he seems to speak so darkly, not only in his translator's Latin, but in his own Greek, that if he have given a good solution of the difficulty, I must ingeniously confess my dulness, in not being able to understand it.

BUT, to consider the difficulty itself, there are two accounts, on which the actions of natural agents may be said to tend to a certain end: one, when the agent has a knowledge of that end, and acts with an intention to obtain it; as when a man shoots an arrow to hit a mark: the other is, when the action of the proximate agent is indeed so directed, as it ought to be to obtain an end, and yet that end is neither known nor intended by the proximate agent, but by a remoter agent, that is intelligent. In the former of these senses I cannot admit, that (not now to examine, whether any living but not rational works of nature may) any inanimate bodies can act for an end; for to do so, presupposes, that the agent both knows the end he is to attain, and purposes to attain it; which are things whereof inanimate bodies are incapable. And to fancy with some, that they may have a knowledge *sui generis*, (as they speak) which, though confined to the actions proper to this or that particular kind of body, is yet sufficient to determine to those actions, is to offend against that rational and received rule of philosophizing, *Entia non sunt multiplicanda sine necessitate*, and to introduce a sort of knowledge, which I fear the proposers do not well conceive, or, at least, I am sure I do not.

IT remains then, that I embrace the second sense, in which we formerly said, that natural things may be said to work for an end; though indeed, in this case, we must speak somewhat improperly: for, by him, that considers, the action will be oftentimes more justly attributed to the intelligent, but remoter, than to the immediate agent, which is but, as it were, the instrument of the other. But how this is possible to be done, appears difficult to be explained. To me it seems, it may be thus conceived: the most wise and powerful Author of nature, whose piercing sight is able to penetrate the whole universe, and survey all the parts of it at once, did, at the beginning of things, frame things corporeal into such a system, and settled among them such laws of motion, as He judged suitable to the ends He proposed to Himself in making the world: and as by virtue of his vast and boundless intellect, that He at first employed, He was able not only to see the present state of things He had made, but to foresee all the effects, that particular bodies so and so qualified, and acting according to the laws of motion by Him established, could in such and such circumstances have on one another; so, by the same omniscient power, He was able to contrive the whole fabric, and all the parts of it, in such manner, that, whilst his general concurrence maintained the order of nature, each part of this great engine, the world, should, without either intention or knowledge, as regularly and constantly act towards the attainment of the respective ends which He designed them for, as if themselves really understood, and industriously prosecuted, those ends.

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Just as in a well-made clock, the spring, the wheels, the balance, and the other parts, though each of them act according to the impulses it receives, and the determination that is given it, by the other pieces of the engine, without knowing what the neighbouring parts (or what themselves) do; yet their tendencies are so determined, and sometimes over-ruled, and their motions so quickened, by the structure of the clock, that they would not move more conveniently, nor better perform the functions of a clock, if they knew, that they were to make the index truly mark the hours, and intended to make it do so. It is true, that it is not easy to conceive, how one agent should, by so simple an instrument as local motion, be able to direct a multitude of agents, as numerous as the bodies that make up a world, to act as regularly, as if each of them acted upon its own particular design, and yet all of them conspired to obey the laws of nature. But if we consider, that it is to God, that is an omniscient and almighty Agent, that this great work is ascribed, we shall not think it incredible; especially if we consider, that, whereas it is manifest enough, that a multitude of bodies act, as we have supposed, if we will not ascribe the direction and super-intendence of the motions, that are manifestly fitted for the attainment of ends, unto God, we must do it to nature, which will not lessen (but increase) the difficulty: and when I have seen, as sometimes I have, with pleasure, a great engine, wherein the works of I know not how many trades, and a great many other motions, were performed by little puppets, that managed the tools of the artificers; and all these were set a-work by one spring, which communicated motions, that were regulated and determined by the particular structure of the little statues and other bodies: when, I say, I consider such things as these, I cannot think it impossible, that the

Heb.xi.10. divine and great Δημιουργός, as both philosophers and sacred writers have stiled the world's Creator, should be able, by the motions and structure of matter, to set a-work very many partial and subordinate engines. For it will not, I hope, be denied, that the multitude of these does not any thing near so much surpass the number of those, which I saw in the hand of an illiterate tradesman, as the narrow knowledge of that artificer is surpassed by the boundless understanding of an omniscient artist. And it is more, in the making so many and so various bodies act according to their particular designations, and yet all of them conspire to the general ends of the universe, that God's wisdom, and (if I may so speak) his skill is displayed, than barely in the making bodies act appositely for ends to themselves unknown. For if moving bodies be duly displayed, and have a sufficient connection, it is not difficult to direct a few of them to the attainment of an end proposed by an understanding agent, though unknown to the immediate agents: as anciently among the Jewish husband-men, (and at this day in some parts of the East) the ox, that intended no such matter, did, by treading the corn, as well separate the grain from the straw, as our plowmen do, when they thresh it purposely to make that separation: and a horse or an ass in a mill may as well, by his going round, grind the corn, as the miller himself could do.

NOR is this doctrine inconsistent with the belief of any true miracle; for it supposes the ordinary and settled course of nature to be maintained, without at all denying, that the most free and powerful Author of nature is able, whenever He thinks fit, to suspend, alter, or contradict those laws of motion, which He alone at first established, and which need his perpetual concurrence to be upheld.

THE laws of method would oblige me to conclude here this section, and pass to another; but in regard, that all I thought myself obliged to say about it, leaves it so very short, as to be very disproportionate in bulk to the other sections of this discourse, I will crave leave to lengthen it in this place, with something, which, though

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it may be judged to belong more properly to another, will not perhaps be thought to be impertinent here; and much less to be useless to the design of this discourse.

HERE then you may please to take notice, that in all that I have discoursed in the second section, or may elsewhere have occasion to say, against the received opinion, that the whole material world was made for man, I would not be understood to speak either too dogmatically, or too exclusively; my design being to deliver, what I thought might probably be represented to take off the prejudice, that men are generally prepossessed with in their own favour. For though the arguments I alledge against the vulgar opinion, seem as yet to me more probable, than those I have hitherto met with for it, especially as it relates to the vast celestial region of the world; yet I am not only willing to grant, that, among the ends designed by the Author of nature, in several of his works, especially plants, animals, and metals, the utility of men may be one, and perhaps one of the principal; but I am not averse from thinking, that human ends (or uses that relate to men) may have been designed by God in several creatures, whose human uses men are not yet aware of; and that He may have intended, that of several of his creatures, whereof men do already know, and make some uses, they shall hereafter discover other utilities, and perhaps nobler ones.

THOSE, that reflect on the providence of God, whilst they represent, what they call nature, as a step-mother to man, whom she brings naked, toothless, and helpless into the world, whilst she furnishes the new-born fœtuses of brutes with wooll or other clothing, and both with a power to walk and seek their food, and (as to many of them) with teeth to eat it: those men, I say, have been long ago answered by the eloquent *Lactantius*, and other champions of Providence. And therefore I shall only add this, that God, by giving man necessity and reason, has effectually excited him, and richly furnished him with ability, to procure for himself far greater accommodations and advantages, than those beasts come into the world with; and, by vouchsafing him that noble faculty of understanding, He has put it in his power to convert to his own use those very things, for which profane wits would have the condition of beasts preferable to his. For man, by his reason employing skilfully such admirable instruments as his hands, is able to master and apply to his own uses the fierceness of several wild beasts, as leopards (which the Persians hunt with) the vast strength of elephants, the huge bulk of whales, the sagacity of spaniels, hounds, and setters, the swiftness of grey-hounds, the subtlety of tumblers, and the furs of beavers, martins, &c. to omit a multitude of others, which God, by the single gift of reason to man, has enabled him to master and make use of to his own advantage. And though at first he be helpless enough, and unable to exercise his dominion over inferior creatures, yet God has sufficiently provided for him, by giving his parents, whilst he needs them, that (*σὸφυν*) natural affection for him, which engages them to take care of him, till he be in a condition to take care of himself, and become qualified to obtain such knowledge and industry, as may make him possessor of the advantages, whereof his indulgent and bountiful Creator made him capable.

THOSE moderns, that think it ridiculous to imagine, that, in framing such vast bodies as the earth, and some of the celestial globes, their Creator should have any regard to so small a part of the earth as man, and designed, that they should be some way or other serviceable to him, look upon things rather as surveyors, who consider mainly their extent, than as philosophers, that estimate them by their intrinsic value. For though it be true, that man, considered barely as an animal, is a creature little enough to be contemptible; yet as he is endowed with a soul, immaterial, rational, and immortal, he is a creature much more noble and excellent than the whole terraqueous globe, or a much vaster mass of corporeal substance;

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that is stupid and inanimate. For the rational soul is capable of understanding and willing, (which are higher faculties than mere matter can reach to) and, which is more, of knowing, serving, and enjoying God. And man being the only visible creature, that is capable to understand the wisdom, power, and beneficence of God in the creation, and in many ways to subdue a great variety of the other creatures, and apply them to his uses; it ought not to seem strange, that the wise Author of the universe, that made all things so as to bring glory to Himself, should have a more especial regard to so noble a piece of his workmanship, than to any, that, being merely corporeal, can neither understand his wisdom and his power, nor render Him thanks nor praises for the manifold and admirable effects of them. And that littleness, that is alledged to make man a contemptible creature, is so far from being a disparagement to that noble part of him, the soul, which makes him a man, that is, a rational creature; that its excellency consists in being less than the minutest body; since, not having extension, it is not divisible; which is the prerogative of substances, which, for that reason, are immaterial and immortal.

THIS mention of the human mind leads me to a further reflexion, which is, that many parts of the material world, whereof man has not been known to make any advantage in the capacity of a mere animal, may yet be highly useful to him as he is a rational creature, that is capable, by contemplating the great and admirable works of God, to raise his mind to the acknowledgment of the divine Architect's power, wisdom, and beneficence, and thereby find produced in him due sentiments of veneration, gratitude, and love. And these may be safely reckoned among those ends or uses, which in the first section we have stiled human ones; since some of the heathen philosophers themselves called the world a temple, and one of the more philosophical fathers of the church loftily stiles it, *ταυδ' ἑστέριον τῆς θεογνωσίας, καὶ ψυχῶν λογικῶν διδασκαλεῖον*.

AND indeed we find, that the psalmist alone may furnish us with divers instances to our present purpose: for not only he teaches us that *the heavens declare the glory of God*, and that in a language, that, notwithstanding what happened at *Babel*, reaches to all the nations of the world; but he employs the contemplation of God's visible works, to excite in himself and others true sentiments, both of devotion and of particular virtues. Thus the consideration of his having been wonderfully formed in his mother's womb, moves him to revere and celebrate the admirable skill of the Opificer. Elsewhere the consideration of the regular vicissitudes observable in the course of nature, invite him to admire and extol the providence of God. And when, in another place, he beholds those vast bodies and shining ones, that compose and adorn the cœlestial part of the world, he justly falls into sentiments of great humility and deserved gratitude.

AND as to this use, the distance and vastness of the fixed stars, the immensity of the heavens, and the regular motion of the superior planets, (supposing they can bring man no other advantage) may do him good service, since they afford him rational and solid grounds to believe, admire, adore, and obey the Deity. For by thus spiritualizing (if I may so speak) the corporeal works of God, there may accrue to the pious soul uses far more valuable than they can afford the body; since they will perfectionate the mind here, and continue to be advantageous to it, when the body will not need the world, and the world itself, as to its present constitution, shall be destroyed.

BUT to proceed from this use of the world, which is theological, to a human use, that is more physical, as relating to the present welfare of man, as he is an animal, as well as a rational creature; I shall represent, that as a nation is oftentimes, in the
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Ex. iv. 22.
Hof. xi. 1.

account of Providence, considered as one man, notwithstanding its various dispersions, and perhaps long continuance; as the *Israelitish* people, during many ages, notwithstanding its divisions and captivities, was addressed to and treated, by the prophets and apostles commissioned by God, as one person, named *Israel*, whom God, sometimes in the scripture, is pleased to call his son: so perhaps it will not be absurd to conceive, that mankind itself may in some regards, or as to some purposes, be looked upon, by its Author, as one man, who, by successive improvements of his knowledge, may, from time to time, be enabled to make new and considerable uses of the things, that the wise and bountiful providence of his Maker had framed with a foresight that he would, and with intention that he might, make them advantageous to him. And therefore it cannot safely be concluded that every thing, whose usefulness to man is not yet obvious, nay, that every thing, that seems hurtful to him, can never be made beneficial to him. For we see, that opium was, for many ages, looked on only as a poison, but now is employed as a noble remedy, (as indeed it is, if skilfully prepared, and judiciously exhibited) in many violent, and oftentimes dangerous distempers. Vipers are venomous animals, but yet their flesh is a main ingredient of that famous antidote treacle; and being in great part dissolved in tract of time in good Spanish wine, I have tried it with surprising success, in an uncommon and very difficult case. Scorpions also afford, by bare infusion, an oil that not only cures their own stings, but is very available in several distempers. And I remember, that a learned professor of *Padua*, having cured the widow of a sovereign prince of a fit of the stone, answered me some few days after, that the chief remedy he employed and relied on, was a preparation (which he intimated to consist mainly in a light kind of calcination) of scorpions, which, somewhat to my wonder, he made his patient take inwardly. And, though the roots of maudioca be reckoned among poisons, when the juice is in them, of which I elsewhere relate a notable instance; yet when the juice is pressed out, and the firm part reduced to meal, it affords the cassava, which is the common bread of a great part of the *Americans*; and I did not scruple to eat of it here in *England*: nay, the poisonous juice itself, in divers places of the *West-Indies*, is, even by the unskilful inhabitants, turned into an ordinary, and, by them, beloved drink. But enough of this sort of instances. I shall be more brief in those of another kind, whereof the first is afforded by the loadstone, which (though, for many ages, admired by the Greeks and Romans, for what is commonly called its attractive virtue) had not its directive virtue known, at least any thing vulgarly, in these parts of the world, till within less than four ages; since when, of what vast use this stone has proved to mankind, the discovery of the *West-Indies*, and of the way of sailing by the *Cape-of-Good-Hope* to the *East-Indies*, sufficiently declares. I will say nothing of the uses of the silk-worm, and the sugarcane, which were little taken notice of for many ages, even by the civilized and luxurious *Greeks* and *Romans*; but now, together with the lately discovered cochineal, which is but an insect, and far less than the silk-worm, make a good part of the trade of *Europe*, and furnishes the tables of the delicate with sweet-meats, and the courts of princes with many of their finest ornaments. But not to insist on such things as these, but to proceed.

It deserves also to be considered, on this occasion, that many things, that are not thought useful to men, because we see not, that they directly bring in any immediate advantages, may yet be of great use to them, as they minister to (or are necessary for) other things that are very serviceable to them. As the excessive rains, that cause the over-flowings of rivers in divers parts of *Afric*, and some other countries, though they seem rather destructive than profitable, do yet, by their seasonable

inundations, make *Egypt*, and some other countries, exceedingly fertile, that without them would be very barren: and among us, those clouds, that do us no immediate service, do oftentimes, by watering our fields and gardens in summer, and by manuring them, as it were, in winter, nourish those trees, grass, corn, herbs, and other plants, whereof some serve immediately for aliments to man, and others are necessary for the nourishment of sheep, oxen, deer, and other beasts, that men usually feed upon.

Not only plants and animals, and stones and metals, and such other smaller bodies, as are within man's reach, are capable of being made use of by him; but, to advance a step farther, to far greater masses of matter, and even some of those remote celestial globes, which he is thought able only to contemplate; one of those ends, to which the indulgent Creator destinated them, may be to be serviceable to man.

To say nothing of the advantage, that skilful seamen make of the ebbing and flowing of that vast collection of waters, the ocean; the declination of the mariner's needle, and the variation of it, which probably depends upon the motions or changes of some vast internal portion of the terraqueous globe, is found to be of great use by experienced pilots and navigators, in their voyages through those vast seas they use to pass between *Europe* and the *East-Indies*; as I learned by particular inquiry from eminent persons, that have more than once sailed upon those seas. The moon, to omit her light, serves men, not only to make moon-dials by, and to foretel regularly the times and quantities of the various ebbings and flowings of the sea, the knowledge of which is very beneficial, if not necessary, to mariners, but serves mathematicians for divers other purposes. The sun, not to mention his ordinary light and heat, and the necessity of them to the plants and animals, that afford man food and medicines, and to the production of many other effects, whereon his welfare depends, do enable him, by concave and convexed glasses, to burn with celestial beams, without the help of culinary fire; and enable the gnomonist to make accurate dials, to know exactly how the time passes; the cosmographer to make very useful discoveries of the elevation of the pole, and latitudes of places; and the heedful observer of his rising and setting, to discover what artists call his amplitude, which is of good use to astronomers, and more to navigators, by helping them to estimate, among other things, the variation of the compass, from true north and south points. And the conjunction or opposition of the sun and moon in eclipses, though it be a frightful thing to the superstitious vulgar, yet to knowing men, that can skilfully apply them, these eclipses are of great use, and such as common heads would never have imagined; since not only they may, on divers occasions, help to settle chronology, and rectify the mistakes of historians, that writ many ages ago; but, which is, though a less wonder, yet of greater utility, they are, as things yet stand, necessary to define, with competent certainty, the longitude of places or points assigned on the terraqueous globe, which is a thing of very great moment, not only to geography, but to the most useful and important art of navigation. And lastly, at how stupendous a distance soever the fixed stars are placed, yet their remoteness cannot hinder the industry of man from making even these serviceable to his uses; since, if we should admit those determinate celestial influences, that are little less than the idols of astrologers, they would enable us to predict the changes of weather, the fertility and dearth, the sickness or healthiness, of any proposed season: and, not to lay any stress upon so controverted a science, it is plain, that skilful navigators can make use of any of the fixed stars, to know by any of them, what hour it is of the night: and it is more known, that fishermen and pilots did generally, for many ages, till within these four last centuries, make very great use of the pole-star, and

and other of the northern fixed ones, to guide them, when nothing else could, in the perilous courses of their navigations.

I HAVE seen, and been master of a telescope, made in the form of a walking-staff, so that it was fitted to serve for several purposes, whereof though one was very different from the other, yet all of them were in the idea of the artificer, and intended by him. The like may be said of a concave metalline burning-glass, which though it is employed to magnify the pictures of objects, to cast their images into the air, and to center the sun-beams to a focus, in which they will burn several bodies, yet these and many other things, which, though they seem to have little affinity with these, are performed by a metalline concave, were before-hand destined by the artist, who foresaw and intended, that in such various junctures of circumstances it should produce all those determinate effects.

AND indeed, if we consider God's omniscience and providence, and how indulgent a Creator He has been to man, it may well seem reasonable to think, that as God foresaw, that men might make very various and profitable uses of divers of his other creatures, by the help of that prerogative of reason, which He had vouchsafed them; so He designed, that men should reap the advantages He had made many of his other works capable of affording them. And I confess, I think this reflection may justly serve to recommend the doctrine about Final Causes, that we embrace, to philosophers, that are truly pious; since it furnishes them with just arguments for gratitude to the Author of so many good things, as the corporeal world, by being contemplated or possessed, affords them. For to look upon the world, as vast and curious a work as it is, only as a vast and curious piece of workmanship, may indeed give a man a great idea of the power and skill of the divine Architect; but will rather exact his wonder than his gratitude: and therefore the ancient Aristotelians, who looked upon the world as eternal and self-existent in a condition like its present system, did not use to thank God for the benefits they received from things corporeal; though some of them thought themselves obliged to thank nature, which they looked upon as acting with design, and proposing to herself, for ends, the welfare of the universe and of men. To illustrate this with something, whose application is obvious: if a traveller, being in some ill-inhabited eastern country, should come to a large and fair building, such as one of the most stately of those they call Caravanzeras, though he would esteem and be delighted with the magnificence of the structure, and the commodiousness of the apartments, yet, supposing it to have been erected but for the honour or the pleasure of the founder, he would commend so stately a fabric, without thanking him for it: but if he were satisfied, that this commodious building was designed, by the founder, as a receptacle for passengers, who were freely to have the use of the many conveniencies the apartments afforded, he would then think himself obliged, not only to praise the magnificence, but, with gratitude, to acknowledge the bounty, and the philanthropy, of so munificent a benefactor.

S E C T. IV.

IT remains now, that we discourse a while of the fourth and last question, proposed at the beginning of this tract, which was, *With what cautions Final Causes are to be considered by the naturalist?*

BUT the cases, whereto this question may relate, are so many and so differing, that what I shall endeavour, upon so diffused and difficult a subject, will be rather to point you out some sea-marks, that may direct you to shun those latent rocks, against which divers learned men have dashed, than to present you with a mariner's

compass, and a sea-card, that may constantly guide you, in the courses of your navigation, through so unfrequented a sea.

AND to make way for what I am to offer, by a distinction, the want of which seems to have contributed to the obscurity of my subject, I shall observe to you, that there are two ways of reasoning from the final causes of natural things, that ought not to be confounded. For sometimes, from the uses of things men draw arguments, that relate to the Author of nature, and the general ends He is supposed to have intended in things corporeal: as when from the manifest usefulness of the eye, and all its parts, to the function of seeing, men infer, that at the beginning of things the eye was framed by a very intelligent Being, that had a particular care, that animals, especially men, should be furnished with the fittest organ of so necessary a sense as that of sight: and sometimes also, upon the supposed ends of things men ground arguments, both affirmative and negative, about the peculiar nature of the things themselves; and conclude, that this affection of a natural body or part ought to be granted, or that to be denied, because by this, and not by that, or by this more than by that, the end, designed by nature, may be best and most conveniently attained. This latter sort of arguments I am wont to call purely or simply physical ones; and those of the former sort may, for distinction's sake, be stiled *physico-theological* ones; or, (if we will, with *Verulamius*, refer final causes to the metaphysics) by a somewhat shorter name, metaphysical ones.

WHAT has been premised, about these two ways of arguing, allows me to proceed to what I shall venture, though not without much diffidence, to offer you; concerning our grand question, about which I shall refer my present thoughts to the five ensuing propositions.

PROPOSITION I.

AS to the generality of cœlestial bodies, it seems not safe to propound arguments of their nature, from the supposition of particular ends, at least of the human ones, designed by the Author of nature in framing them.

I will not only allow you, but encourage you, to take a rise from the contemplation of the cœlestial part of the world, and the shining globes that adorn it, and especially the sun and moon, to admire the stupendous power and wisdom of Him, that was able to frame such immense bodies, and, notwithstanding their vast bulk, and (if the earth stand still) scarce conceivable rapidity, keep them, for so many ages, so constant, both to the lines and paces of their motion, without justling or interfering with one another. And I shall most willingly join with you, in returning thanks and praises to the divine providence and goodness, for having so placed the sun and moon, and determined the former (or the earth) to move in such lines, under that oblique circle astronomers call the ecliptic, that there needs skill in cosmography to be able to apprehend, how useful these situations and motions are for the good of men and other animals; and how disadvantageous it would have been to the inhabitants of the earth, if the luminaries had been otherwise placed or moved than they are. But, for all this, I dare not imitate their boldness, who not only affirm, that the sun and moon, and all the stars, and other cœlestial bodies, were made solely for the use of man; but presume to ground arguments, to evince such a system of the world to be true, and such another erroneous, because the former is, as they think, better fitted to the conveniency of mankind, or the other less suited to that end, or perhaps altogether useless or unnecessary to it: as when they argue, that the sun and other vast globes of light ought to be in perpetual motion to shine upon the

the earth; because, as they fancy, it is more convenient for man, that those distant bodies, than that the earth, which is his habitation, should be kept in motion. But, considering things as meer naturalists, it seems not very likely, that a most wise Agent should have made such vast bodies, as the sun and fixt stars, especially if we suppose them to move with that inconceivable rapidity, that vulgar astronomers do and must assign them, only or chiefly to illuminate a little globe, that, without hyperbole, is but a physical point, in comparison of the immense spaces comprised under the name of heaven; whose lights might as well illuminate the earth, if they were a thousand times lesser than they are, provided they were placed at a proportionably less distance from it. And it will be very hard to assign, what considerable use the terrestrial globe or its inhabitants derive from that multitude of cœlestial globes, that make the milky way; since each of those stars is so far from being singly able to enlighten the earth, that *Aristotle*, and the generality of philosophers for many ages, (therein followed by divers of the Peripatetic schools at this day) took the whole aggregate of them for a meteor. And what light, or other known advantage, can the earth or its inhabitants derive from those many fixt stars, that the telescope only can discover, (and which for that reason I sometimes call telescopical stars) among the six or seven conspicuous ones of the *Pleiades*, or among those, that the naked eye can see in the belt or girdle of orion? which (constellations) I scarce ever look upon, through a good telescope, without wonder.

I FORESEE, it may be said, that these and other the like cœlestial bodies may be at least thus far useful to man, as to discover to him, and give him a rise to admire and praise the greatness and power of the divine Maker: and if this be said, I shall not quarrel with the allegation, but readily grant, that though perhaps his wisdom shines as bright to us men, in the structure of a glow-worm, as in the disposition of the unseen stars, that make up the galaxy; yet the immensity of his power could not perhaps be so well declared by less vast productions of it. But still these arguments are not purely physical, but of that sort, that I call physico-theological, whose inferences relate to the general intendments of God in the universe, which I therefore style cosmical ends, but do not reach to prove any thing about the determinate nature of particular bodies. And since the utmost, that philosophy teaches us, is, that in general the good of man was one of the ends designed by God, in so framing the world as we see it is framed; there may be other ends designed by the same omniscient Author of nature, of those telescopical and other small or remote stars, whose uses to us are doubtful or inconsiderable; towards the attainment of which ends, those cœlestial bodies and motions may be admirably contrived and directed. And we not being able by meer reason to investigate what those ends are, though we have not near so much reason to assure us, that there may not be such ends, as the infiniteness of God's wisdom gives us to think there may be; it is presumptuous for us to judge of the system of the world, and of the destinations of fixt stars so remote, that, though they be probably like so many suns, we cannot so much as discern them without good telescopes, by that system's greater or lesser advantageousness to us: especially since, though it were certain, that, among other uses, God intended they should be in some sort serviceable to us, yet He has no way declared to us in what capacity, or to what degree, they shall be useful to us. And therefore if they be so in any measure (as for example mentally) they are so, for what we know, as much as He designed they should be; and that itself, being an unmerited favour, deserves our humble thanks. And it seems very likely, that God did not design to all the parts of the earth itself, equal, and consequently not the greatest, advantages by the present system of the universe; since the countries inhabited by the

Samoids and *Novazemblans*, and other nations, that live very near the arctic pole, want many conveniences and advantages enjoyed by the inhabitants of the temperate zones, that lye nearer the way, in which the sun moves.

BUT, though bare philosophy does not favour the bold opinion I dare not assent to, yet I know it will be pretended, that revelation does. And I readily confess, that the terraqueous globe, and its productions, (among which perhaps the atmosphere may be reckoned) and especially the plants and animals it is furnished with, do by the scripture appear to have been designed for the use and benefit of man, who has therefore a right to employ as many of them, as he is able to subdue: and that

Pf. civ. 19. the two luminaries themselves, the sun and moon, were appointed by God to give light upon the earth, and be useful to all the nations, that inhabit it: and that there-

Pf. civ. 24. fore the kingly prophet had reason to exclaim, *How manifold are thy works, O Lord! how wisely hast thou made them all!* when in the precedent and subsequent words he applies this to the terraqueous globe, and its inhabitants. And he might justly

Pf. xix. 1. say, as he elsewhere did, *that the heavens declare the glory of God, and the firmament sheweth his handy work.* But these general declarations, though they be just motives of our wonder and thankfulness, yet I fear they are not good topics to draw such physical conclusions from, in particular cases, as some learned men adventure to do. For I do not remember, that it is any where declared in the scripture, that the service of man was the only, or perhaps so much as the chief, use of all the cœlestial lights, and other bodies of that immense part of the world. And this single consideration ought to oblige us, to be very wary in making ascriptions to ourselves, as if the great system of the world were to be estimated by our conveniences. And if it be said, that things merely corporeal have not, and man alone has, a rational faculty, whereby to refer the great and wonderful works of God to the glory of their Maker; I shall take the liberty to answer, that, though this has been affirmed by many, if not also assented to by all, yet I have not found it proved by any. And I somewhat wonder, that divines should on this occasion overlook that passage in the 38th chapter of *Job*, which they generally interpret of the angels: for the question, which God there puts to *Job*, may be justly applied to *Adam* himself; *Where wast thou,*

Job xxxviii. 4, *when I laid the foundations of the earth? declare if thou hast understanding. When the morning-stars sang together, and all the sons of God shouted for joy.* And indeed, if we even may presume to conjecture of such things, it seems to me reasonable to think, that God created the angels before the material world, that He might have intelligent beings to pay Him the just tribute of praises for so admirable a spectacle as that of the rising world, or rather the beginning and progress of the creation. However, by the words last cited out of the book of *Job*, it appears, that before man was made (for that he was not till the sixth day) God wanted not intelligent spectators and applauders of his corporeal works. And since the angels are a nobler order of intellectual creatures than men, and are not unconcerned spectators of the works of God; how do we know, but that in the system of that part of heaven, of which we need telescopes to know, that there is such a thing in *rerum natura*; and in the plants, animals, or other furniture, whatever it be, of those particular, and to our naked eyes invisible, stars, that serve us men barely for declarations of their Maker's power; such intelligent spirits as angels may discern as wise destinations, and as admirable contrivances, as those, which, at the forming of the earth and its furniture, invited their devout hymns and acclamations? and in this case, God will not lose any thing of the glory due to the divine attributes displayed in the fabric of the cœlestial part of the world, though the fixt stars should be neither only nor principally designed for the service of men.

To what has been hitherto said, to let you see the reasonableness of my first caution, which represents the making particular and meerly physical inferences from the supposed destinations of cœlestial bodies, as a thing unsafe, I shall now add, in the second place,

THAT it is yet more unsafe to ground arguments of the nature of particular bodies, that are inanimate in the sublunary world, upon the uses we think they were designed for.

THIS will not appear an unreasonable caution, if we consider, how little we know of the particular purposes of nature in those bodies here below, which not being organical, like those of animals and plants, cannot by the curiousness of their structure disclose to us the particular ends, to which they were ordained. And as for their motions, since they are extremely far from being so constant and regular as those of the cœlestial bodies, the caution we gave about drawing arguments from the system of the heavens, will not, sure, be thought unfit to take place, when we speak of clays, chalks, and stones, and the like terrestrial bodies, whose textures are, comparatively to those of living creatures, very simple and slight, and seldom more curious, than may be made by art, by dissolving stones and metals in chymical menstruums, and afterwards chrySTALLIZING the solutions; of which I elsewhere give examples. It is true, that, though revelation speaks rather of God's having destinated animals and vegetables, than inanimate bodies, to the service of men; yet there is no absurdity to conceive, that, generally speaking, that may be one of the ends designed by the Author of nature, in making metals, stones, and those other inanimate parts of the terrestrial globe, that man is able to master and make use of. But whereas in this globe the surface is distant from the center above three thousand and five hundred miles; and I do not find, that either men's spades or their plummeting lines have reached above one mile of that great number; nor is it very likely, that human industry will ever make its way down to the thousandth part of that vast depth: it seems very improbable, that the remaining internal part of the earth, that is above seven thousand miles thick, and may, for aught we know, contain great varieties of fossils and other creatures, should be made chiefly or only for the service of men, from whose sight they lie hid in a deeper well than that of *Democritus*, and who do not so much as know, what kind of bodies they are. And though it will not hence follow, that the terraqueous globe was made by chance, no more than that any of the other planets was so; because the admirable structure of plants and animals evinces the existence and providence of a most wise and powerful Author of things, who may justly be supposed to have made nothing in vain, even among the inanimate portions of our globe, whose animated portions are so wisely and exquisitely framed: yet, that those inanimate bodies were made for determinate ends, is more easy to be deduced from the knowledge we have by other mediums, that they are the productions of a wise and provident Author, than by the contemplation of these inanimate bodies themselves. And perhaps it may be worth inquiry, whether some things may not be made, even by a wise Agent, not out of a primary intention, but as productions, that will naturally follow upon the establishment and preservation of those grand laws and rules of motion, that were most fit to be settled among things corporeal. And it is very possible, that, according to that cosmical establishment, (if I may so call it) many parts of the terrestrial globe should be so placed or disposed of, as not to be serviceable to men; because the whole aggregate, or globulous mass, could not otherwise be so well suited to the general destinations of the universe, which, if otherwise contrived, would perhaps have been less serviceable than now it is to man himself. To countenance which consideration, I shall observe,

See the
Tract of
the Origin
and Virtues
of Gems.

that,

Jotzer hac-
col, Jer. x.
16.

that, though the eclipses of the sun and moon be usually unwelcome, and, if astrologers may be credited, often very prejudicial to multitudes of men; yet the great *Former of all things*, or, as the original will bear it, *of the whole*, did not think fit to alter the tracts or lines of motion, that He assigned the luminaries, to avoid the eclipses, that must yearly ensue upon their moving in such lines. Whence we may also learn, that some phænomena may not belong to the primary intention of nature, but are only the necessary consequences and effects of the primitive constitution of the world, and the catholic laws of motion. And if it be here demanded, what the ends are, for which the deep and hidden parts of the terraqueous globe, and the telescopical stars of the firmament, were made, if they were not made for the use of man, I shall frankly answer, that I cannot tell: and I know not, but such an answer may be more expressive of the profound reverence we owe the great Author of nature, than their opinion is, that would have all these made for the use of man; since to say, that we know not, why some part of a work is made by an artist, whom other parts proclaim to be most wise and skilful, does both acknowledge our own ignorance, and leave it highly probable, that such pieces of work are suited to purposes worthy of Him, and suitable to them; and seems therefore a safer and more respectful opinion, than to suppose Him to have made such things for a particular end, which we cannot make out to be in any considerable measure worthy of his wisdom, and attainable by them.

PROPOSITION II.

IN the bodies of animals it is oftentimes allowable for a naturalist, from the manifest and apposite uses of the parts, to collect some of the particular ends, to which nature destinated them. And in some cases we may, from the known natures, as well as from the structure, of the parts, ground probable conjectures (both affirmative and negative) about the particular offices of the parts.

To obviate mistakes, you may please to take notice, both that in this proposition I speak only of those ends and uses of the parts of an animal, that relate to the welfare and propagation of the animal itself, and which therefore I formerly called animal ends; and yet that I do not thereby deny any declaration, that is made in the holy scriptures, that God designed, that the entire animals, as well as their parts, should be in several ways serviceable to man. And having premised this to explain my meaning in the proposition, I shall now consider distinctly the two parts, whereof it consists.

AND I. There is no part of nature known to us, wherein the consideration of final causes may so justly take place, as in the structure of the bodies of animals. And I confess, that, when I assist at a well-administred anatomy, I do so wonder at the admirable contrivance of a human body, that I cannot but somewhat wonder, that there should be found, among philosophers, men that can ascribe it to blind chance. The Stoic, that (in *Cicero*) asked an Epicurean, why chance did not make palaces and other buildings, seems not to me to have made an impertinent question. For the commodiouslest houses, men's bodies dwell in, are far less curious structures, than the mansions their souls reside in: which you will not think a groundless paradox, if you consider, that, whereas even in a palace, the materials being wood, stone, brick, mortar, glass, and four or five metals, are but few in comparison of the parts of differing textures, as bones, nerves, ligaments, membranes, muscles, veins, arteries, gristles, glandules, jellies, humours, &c. and their disposition is exceeding slight, in comparison of the curious and elaborate contrivance of the numerous parts,

both

both solid and fluid, of the human body; whereof though the stable parts alone have been reckoned to amount to some hundreds, yet in every one of these parts, the bulk, figure, consistence, texture, situation, connexion and aptness for motion, is the most commodious, that can be devised; and all of them are wonderfully symmetrical, both to one another and the whole body; to divers of whose motions, as leaping, running, speaking, swimming, sneezing, &c. a great number of them conspire. And this number of parts is so artificially contrived and packed together, that though in a body, where no room is lost, many parts do at the same time exercise very differing motions, each of them moves freely, and does not at all hinder another, but rather they promote each other's motions.

I WILL not suffer indignation to transport me so far as to wish, that those, that deny the usefulness of all the parts of their bodies, may fall sick, or receive some wound, to be thereby at once convinced and punished: but I will venture to say, that diseases or hurts alone may shew, how excellently all the parts of our bodies are contrived in order to our welfare. For if so much as a finger be made bigger by tumors, or displaced by being put out of joint, or kept in a wrong posture by contractions, or have its continuity violated by cutting, or its tone changed by strains or contusions, or its sense or motion taken away by the palsy, or its membranes fretted by sharp humours, or its motions disordered by the cramp or convulsions; in any of these cases we quickly find, how commodiously the parts affected were framed or disposed, when any disease or hurt gives them a præternatural constitution; that is, changes that figure, connexion, tone, &c. which, according to the institution of nature, whilst the body is in full health, does belong to it.

THE eye (to single out again that part for an instance) is so little fitted for almost any other use in the body, and is so exquisitely adapted for the use of seeing, and that use is so necessary for the welfare of the animal, that it may well be doubted, whether any considering man can really think, that it was not destinated to that use. The six or seven muscles, that move the whole bulbe of the eye, upwards, downwards, to the right hand, to the left, and to various oblique positions; and the several coats and humours, that make up the sensory, have not only their bigness, shape, consistence, situation and connexion, admirably adapted to that end; but the transparency of the cornea and the humours, the opacity of the uvea, and the semi-opacity of the retina, and the several motions of the parts of the eye, being requisite to receive, transmit, refract, and dispose the visive beams, that come from the object, after the manner requisite to make the liveliest picture of it in the bottom of the eye, do no less concur to compleat this matchless organ of vision: which is so rarely contrived in order to that use, and comparatively so little to any other, that there is no more rashness to say, that an eye, than that a telescope, was made for an instrument to see with; that is, to discover the colours, magnitudes, shapes and motions of distant objects. And in that admirable perforation of the uvea, which we call the pupil, nature has much outdone art; for whereas we are fain to apply to the object-glasses of telescopes opacous bodies with several circular apertures, that some may let in less light, and others more, according as the objects are more or less bright or enlightened; that part of the uvea, that hangs in the aqueous humour, is an aperture, as the artists call it, that narrows and opens itself in a trice, according to the exigency of the objects we look on; which if they be so constituted or placed, that they reflect but a dim light, the curtain is presently drawn open, and the pupil circularly widened, to let in the more beams of light; and the contrary happens, as often as the object, being too luminous or illustrated, would offend the organ, or disturb the sight, if the contraction of the pupil did not shut out some of its beams. But for the uses of

the several parts of the eye, I shall refer you to the industrious Jesuit *Scheiner's Oculus*, and *Des Cartes's* excellent *Dioptrics*; where you will easily perceive, that, in framing the eye, nature did not only act with design, but with so much skill in optics, that a more than ordinary insight into that science, is necessary to understand the wisdom of the contrivances; and perhaps no degree of skill in it would enable a man to alter them for the better. It were tedious to mention the other parts of the body, that manifestly appear to have been pre-ordained to certain uses. The books of anatomists are full of passages applicable to this purpose; of which I shall say in general, that though what they deliver suffices to shew, that all the parts of the body are the effects of an intelligent cause: yet, unless their descriptions and reflexions be improved by men versed in mathematics and mechanics, and, I shall venture to add, in chymistry too, we shall but imperfectly understand, how intelligent that cause is, or how much wisdom it has displayed, in the structure of a human body, and each of its parts.

*Illud in his
rebus vi-
tium vehe-
menter
inepto effu-
gere, illo-
rumque er-
rorem præ-
meditemur,
lumina qui
faciunt oculo-
rum clara
creata prof-
picere ut
possimus,
Lucret. de
Nat. l. iv.
Nihil ideo
quoniam
natum est
in corpore
ut uti posse-
mus, sed
quod na-
tum est, id
procreat
usum. ibid.*

I KNOW it is objected by the Epicureans, that the parts of animals were first made; and their uses afterwards found out by men's sagacity. But this is a sophistical objection. For, first, as to many of the inner parts, as the heart, liver, spleen, kidneys, &c. they perform their functions without so much as our knowledge of their structure; or perhaps their situation; so far are they from being applied to such uses by our sagacity. And as for the limbs and other parts, which we can move at pleasure, it is true, that they cannot be actually employed to the respective uses, till they be actually formed; but that hinders not, but that in their formation they were therefore so formed, that they may be in due time fit for such uses. And therefore we see, that the chick is furnished with compleat eyes, and with wings and feathers, before he be hatched; though, whilst he is yet inclosed in the egg, he cannot make use of them to see or fly. And why was it, do the Epicureans think, that nature provided a whole set of temporary parts for pregnant females, and animals in the womb, which, when they are come into a freer state, partly fall away of themselves, and partly turn to a ligament, fitted no longer for the former, but for a more seasonable use? And it is to be noted, that the production of these umbilical vessels, and the placenta or analogous body in the womb, to which they are fastened, is of no necessity nor use to the female before conception; and thereby those temporary parts appear to have been designed by nature, not so much for the personal preservation of the female as for the propagation of the species: which destination not coming to be accomplished, till a woman, for instance, has attained to a competent age, appears to have been pre-ordained by the author of mankind for the continuation of it.

AND though it be true, that the sagacity of men may have found out some uses of some parts of their bodies, that cannot be made appear to have been primarily intended by the author of nature; yet that is no good argument, that those uses were not intended, which either are made within us, or do, as it were, obtrude themselves upon us. And as for other uses, the prescience and goodness of God are such, that it ought not to appear incredible, that he, that gave man both the limbs of his body, and the rational endowments of his mind, and that has made many parts, as the eyes and the ears, double, that one may supply the want of the other; did both foresee what uses men might, according to their sagacities and emergencies, make of these parts, and so contrive the parts, that they should be applicable to such uses. Suppose a wise man should send his son to travel, and among other things give him a pocket-dial with a magnetic needle; and this traveller having lost his way in some wild plain, or being at sea in a vessel, whose compass was broken or spoiled by a storm, or some other mischance: if, I say, in this case, though the traveller ordina-
rily

rily employed his dial only to find the hour of the day, he shall now employ it to guide his course or steer the vessel, by the help of the needles pointing northward; though this would be an effect of his own sagacity, yet his father, being a wise and experienced man, may reasonably enough be supposed to have foreseen, that his son might have need of knowing the northern and southern points of the horizon; and accordingly may have given him a dial furnished with a magnetic needle, rather than an ordinary gnomical dial. And so a man, that has taught another to paint landfkips, when he gives him a pencil and a pallet furnished with colours, to draw a particular prospect, is not to be supposed to have designed, that he should not employ them to any other purpose, if urgent circumstances made it requisite for him to do so.

HAVING insisted longer than I intended upon the former part of my proposition, I now proceed to the latter; namely, that in some cases we may from the known ends of nature, as well as from the structure of the parts, ground probable conjectures, both affirmative and negative, about the particular offices of the parts: which I could not seasonably do before, because the arguments, that were founded on the uses of the parts of animals, suppose not only, that those parts were destinated to particular uses knowable by us, but that the several parts of the body were contrived as wisely and commodiously, as men are able to devise, in order to the ends of nature; which is always to be understood to have united in her designs the uses of the parts, and the welfare of the whole.

AND indeed if we consider, how admirable a fitness there is in the parts of the human body, for instance, to those particular ends we can discover them to have been predestined for; it seems allowable to conjecture, that such a part was not primarily designed to such an use, because it is, on the account of its structure or otherwise, less fitted for it, than the constant wisdom of nature seems to require; especially if there be any other parts, by which that office may be more commodiously performed. And on the other side it may be a probable ground, though not altogether so probable as the former, to conclude, that such a part was destinated to such an use, if the use itself appear to be necessary, and the part better fitted for it than any other is.

THUS, though anatomical and optical writers, as well as the schools, did for many ages unanimously conclude the crystalline humour to be the principal seat of vision; yet the industrious *Scheiner*, in his useful tract, intituled *Oculus*, does justly enough reject that received opinion, by shewing, that it suits not with the skill and providence of nature, to make that part the seat (or chief organ) of vision, for which it wants divers requisite qualifications, especially most of these being to be found in the retina. And I remember, that when I asked our famous *Harvey*, in the only discourse I had with him, (which was but a while before he died) what were the things, that induced him to think of a circulation of the blood? he answered me, that when he took notice, that the valves in the veins of so many parts of the body were so placed, that they gave free passage to the blood towards the heart, but opposed the passage of the venal blood the contrary way; he was invited to imagine, that so provident a cause as nature had not so placed so many valves without design; and no design seemed more probable, than that since the blood could not well, because of the interposing valves, be sent by the veins to the limbs, it should be sent through the arteries, and return through the veins, whose valves did not oppose its course that way.

THUS, whereas former anatomists and physicians generally believed the nutrition of the parts by the venal blood, the more recent writers are wont to teach, that the parts are nourished by the blood in its passage through the arteries. Not that they think the blood, that runs through the veins, altogether unfit to irrigate the parts with that vital liquor; but that they judge the veins to be less fit than the arteries,

into which the blood comes immediately from the left ventricle of the heart, agitated and spirituous, and with a brisk impulse, which forces out the particles of the blood, at those pores of the arteries, that they find congruous to their shape and size, and which answer to the several parts, that are to be nourished by corpuscles so qualified. It were not difficult, if it were necessary, to accumulate instances to the same purposes with those already mentioned; there being nothing more frequent in the books of anatomists, and those that treat of the physiological and pathological parts of physic, than to draw arguments, as well affirmative as negative, about the use of the parts of the body, from their fitness or unfitness, or their greater or lesser fitness, to attain such ends, as are supposed to have been designed by nature. And indeed these argumentations occur so frequently, that I think there is less need of my increasing them, than of my proceeding to give you a caution about them, which I shall do in the following proposition.

PROPOSITION III.

IT is rational, from the manifest fitness of some things to cosmical or animal ends or uses, to infer, that they were framed or ordained in reference thereunto by an intelligent and designing agent.

DIVERS things have incidently been said in this paper, especially in the first section of it, and others may hereafter be occasionally added, that may justly be employed against that part of the Epicurean hypothesis, which ascribes the origin of things to chance, and rejects the interest of a deity, and the designing of ends, in the production and management of natural things. But because I observe, not without grief, that of late years too many, otherwise perhaps ingenious men, have with the innocent opinions of *Epicurus* embraced those irreligious ones, wherein (as I was saying) the deity and providence are quite excluded from having any influence upon the motions of matter, all whose productions are referred to the casual concurrence of atoms: for this reason, I say, I thought it a part of my duty, as well to the most wise author of things, as to their excellent contrivance and mutual subserviency, to say something, though but briefly, yet distinctly and expressly, to shew, that, at least in the structure and nature of animals, there are things; that argue a far higher and nobler principle, than is blind chance. But that I may do what I here intend, with as much brevity as I can, I will do little more than name some particulars, that I have not observed to be so usually reflected on to the purpose, for which I mention them. And I shall confirm these considerations but with one instance, and that too taken from a sort of parts, that are as little elaborate, and therefore seem to be as little fit for my purpose, as almost any in the human body.

I WILL not now inculcate what has been delivered, and may be farther said, of that exquisite structure of the bodies of dead animals, that is discoverable by the knives of anatomists, (though I shall not scrupulously forbear to touch lightly on a few things of that kind, that are requisite to my purpose;) my present design being to set down very briefly a few arguments, to strengthen the proposition lately delivered.

FIRST then, I observe that there seems to have been care taken, that the body of an animal should be furnished, not only with all things, that are ordinarily necessary and convenient, but with some superabundant provision for casualties. Thus, though a man may live very well, and propagate his kind, (as many do,) though he have but one eye; yet nature is wont to furnish men with two eyes, that, if one be destroyed or diseased, the other may suffice for vision. And so, if one ear grow deaf, a man may be conversed with, by the help of the other, that remains sound. In short, nature

nature has furnished men with double parts of the same kind, where that duplicity may be highly useful, and can be permitted without incongruity to the rest of the body. And this is the more considerable, because in other parts nature appears to husband things so, as to shun doing things superfluous: as within the skull, some vessels, that would in other parts of the body have double coats like other arteries, are much thinner, almost like veins; the thickness of the skull being ordinarily a sufficient fence to them from external injuries.

ANOTHER argument, that divers things, that nature does about animals, are done with design, may be taken from what anatomists observe of those parts of the womb or the foetus, that are to be found but at certain times, at which there is need of them, and not at others, when they would be useless. Thus, when a woman is with child, the vasa umbelicalia are produced, to be channels either for the blood or alimental juice and spirits, that then ought to pass between the womb and the foetus; which is to be nourished, either only or chiefly, by the liquors derived to it through those vessels, assisted by the placenta, that supply to it the want of eating with the mouth, which the unborn infant either does not at all, or does but very imperfectly, employ to feed himself. And though as long as he continues imprisoned in the womb-state, these temporary parts, (if I may so call them) continue with him; yet, as soon as he comes abroad into the world, these umbilical vessels, particularly the two arteries and the vein, together with the membranes they are wrapt up in, and those (commonly called the chorion and the amnios,) that involve the foetus, are thrown off, as unnecessary to the born infant's new state, and, when it has quitted the womb, are expelled after it, whence they are called the after-birth; there remaining only that part of the umbilical vessels, that lies within the child's abdomen, between the navel and the liver, where its use is considerable, though new; it serving no more to convey blood, or an alimental liquor, to and fro, but degenerating into a ligament.

To the same purpose with this contrivance, we may mention that other, wherein nature employs the foramen ovale, that gives passage to the blood from the right ventricle of the heart to the left; that the circulation of it may be maintained, though it cannot in the embryo, as it does in a born child, pass through the vessels of the lungs from one of the ventricles to the other. For this foramen ovale being but (if I may so call it) an expedient, that nature employs, as long as that, which is intended to be an infant, remains an embryo; this temporary conformation is obliterated, when the child, breathing the free air, is in a condition to make the blood circulate through the pulmonic vessels, according to the primary intention of nature. From which and the like instances we may infer, that these temporary parts were framed by a fore-casting, as well as designing agent, who intended they should serve for such a turn, and then be laid aside; it being utterly improbable, that an undesigning agent should so appositely and exquisitely frame scaffolds for the future buildings, if he did not before-hand destinate both the one and the other to concur to the same ultimate effect.

ANOTHER argument for our present purpose may be drawn from the consideration of those things, that in animals are commonly called instincts; whereof some more directly regard the welfare of the individuals they belong to, others the propagation of their species, and some again respect them both. The writers of voyages, and those, that professedly deliver natural history, recount strange, and scarce credible, instances of the instincts observable in certain animals. But we need not lay the stress of our argument upon dubious, or suspected relations; since what I have met with in authors of good authority, or received from the mouths of travellers of

good

good credit, may serve my present turn; especially if it be allowed, (as I see not, why it may not be,) to take the word instinct in a latitude, so as to comprise those untaught shifts and methods, that are made use of by some animals, to shun or escape dangers, or to provide for their future necessities, or to catch their preys.

DIVERS strange things are delivered, not only by poets, but by more credible writers, about the wonderful sagacity and government of bees, in point not only of oeconomy, but of politics too. But though I shall not build any thing upon the authorities, that I myself suspect, yet, having had the curiosity to keep for a good while in my closet a transparent hive, whence there was a free passage into a neighbouring garden; and having thereby had the opportunity to make frequent observations of the actions of these little animals, and particularly to see them at work about making their combs, and filling them with honey; I confess I discovered some things, that I did not believe before, and was induced to look upon them as very fit instances of creatures endowed with natural instincts and providence. For it were hard for a mathematician, in contriving so many cells, as they make in the area of one of their combs, to husband so little space more skilfully, than they are wont to do. And not only they carefully and seasonably lay up their honey, to serve them all the winter, but curiously close up the particular cells with covers of wax, that keep the included liquor from spilling, and from external injuries. I do not here mention the prognostication of weathers, that may be made in the morning by their keeping within their hives, of flying early abroad to furnish themselves with wax or honey, or by their unexpected return before a storm unseen by men; because I suspect, that these things may not be so much the effects of instincts, as of a tenderness and quickness of sense, such as may be seen in a good weather-glass, and found in divers wounded and crazy persons, that are affected with such beginnings of the changes of the air, as are not yet perceived by other men. But among the peculiarities to be observed in the conduct of bees, I cannot but take notice, that after a fight, I have not without some wonder, seen them take up the dead, that lay on the ground, and fly away with them to I know not what distance from their hive.

ANOTHER obvious instance of the instinct, that nature has given even to some despicable insects, may be taken from ants, to whom *Solomon* sends the sluggard to school, to learn the providence of making seasonable provision for the future. For it is known, that these little creatures do in the summer hoard up grains of corn against the winter. And their sagacity is the more considerable, if it be true, what divers learned persons affirm, that they eat or bite off the germens of the grains of corn they lay up, lest the moisture of the earth exposed to the rains should make it sprout. But whatever become of this tradition, these insects do some other actions, resembling sagacity and industry, that are not so contemptible as their bulk, though I must not stay to mention them particularly in this place.

THE untaught skill of spiders, in weaving their curious webs, that are so fitly contrived both to catch their flying prey, and give them immediate notice of its being caught, is a thing, which, if it were not familiar, would be looked upon as admirable. And this skill is not, as some imagine, an effect of imitation of their parents: for if the eggs be taken away and inclosed in a glass, when they come to be hatched by the heat of the sun, the little creature will immediately fall to spinning in the glass itself, as was related to me by an eminent mathematician, that made the experiment. And I saw the less reason to distrust it, because, having by an external heat hatched many eggs of silk-worms, in a place, where there had not been any of a long time before, nor probably ever till then, yet the worms produced by these eggs did in autumn, of their own accord, climb up to those convenient
places

places I had prepared for them, and there weave those curious oval prisons, in which they enclosed themselves, and which are unravelled into silk, of whose extreme fineness or slenderness I have elsewhere given an account.

NOR is the provident industry of animals confined to insects, of whom the poet, (if his words be taken in a popular sense,) truly saith:

Ingentes animos angusto in pectore versant:

Since it is to be found in divers of the greater animals, particularly in beavers; of whom though some things, that are recounted by authors and travellers, are but fabulous; yet what has been related to me by sober and judicious persons, that were either born or lived in *New-England*, where, these animals abounding, they had the opportunity to observe them, is sufficient to confirm such relations, as may give one just cause of wonder. For these credible persons affirmed, that the beavers with their sharp teeth (whose shape and strength I have admired) cut pieces of wood so, as to make them fit for their purpose: that, by associating their labours, they lay these together so, as to build themselves strong winter-houses, in which there is sometimes a kind of second story, for the inhabitants to retire to, when the water chances to overflow: that for these houses they chuse a very convenient situation, just by some river, or other water, that can furnish them with fish: and that the overture or hole, that belongs to each of these houses, is placed just by the water, that they may immediately flounce into it, and so save themselves, when their houses are attacked. And to facilitate their swimming away, and the catching of their prey in the waters, nature has furnished them, as I have observed with pleasure in a live beaver, with two feet, not made like those of dogs, or cats, or like their own two other feet, but furnished with broad membranes betwixt the toes, like the feet of geese, ducks, and other aquatic animals, that are to use them as oars, to thrust away the water, and facilitate their motions upon it, and in it.

IT were easy to accumulate instances of the sagacity and industry of animals, for their own preservation; but it is more easy to find notable ones among those actions, that concern the propagation of their species.

The various arts employed by animals of differing kinds about the materials, the construction, and the situation of their nests, is usually remarkable, and sometimes wonderful. Of this skill we have divers eminent instances, some of which I have been delighted to see, but have not time to recount. Yet one there is, whose oddness will not suffer me to pretermit it. For in a country that abounds with apes and monkeys, that are very greedy of birds-eggs, and oftentimes climb trees to come at them, there is a sort of birds, whose eggs they peculiarly affect, that do, as it were, hang their nests at or near the end of some long flexible branch or wand, that grows over the water; by which means their insidious enemies, who do not swim, cannot come at them underneath; and by reason of the yielding of the flexible branch or twigs, whereto the nest is fastened, they are frighted from venturing to pass on, for want of a firm support.

THE structure of the nests of wasps, which they often make under ground to secure them, I have observed to be very curious and artificial, especially when the young ones are formed in the little cells, where they lie hid and sheltered, till they are ready to fly away.

I MIGHT here multiply examples of this kind, but I think it fitter to proceed, by telling you, that the instincts, that nature has implanted in animals to preserve themselves, though they would seem admirable if they were less familiar, are much inferior

inferior to that providence, that she has furnished animals with, for the propagation of their species.

THERE are divers notable things to be met with in the nests of several birds, both as to their materials, their structure, and the very situations of the places pitched upon to build them in. I have seen some nests, especially Indian ones, which would make a man wonder, how the birds, that built them, should seek and find such odd, and yet, all circumstances considered, commodious materials to build with. Of which we have an eminent instance in the nests of certain Eastern birds, whose names I remember not, that make their nests of a white substance, (which has been presented me by some of our East-India merchants,) that looks almost like ichthyocolla, in the shops commonly called isinglass, and is dissoluble in liquors, and so very well tasted, that it makes the chief sawce, that they use in the southern parts of India at their feasts. The structure also of the nests of divers birds, both as to their figure, their capacity suitable to the bulk of the builders, and the accommodations they are furnished with for warmth and softness, may deserve to be applauded by mathematicians themselves; especially if it be considered, that these little untaught architects had no tools to make their curious buildings with, save their beaks and their feet. And yet much more of providence and foresight appears in the situation of the places, that some birds make choice of to build their nests in: as may be observed, not only in the pendulous nests of swallows, and the crafty hidden ones of some European birds, but very conspicuously in the hanging and moveable nests, that we lately mentioned to be so oddly placed by some birds, to secure their eggs from apes and monkeys; and by the situation of the well-tasted nests I was newly speaking of, which are to be found only upon high and steep rocks, and are so fastened to those concave parts of them, that look downwards, and, for the most part, hang directly over the sea, that there is no getting them without much trouble and danger, by the help of boats and poles: upon which account, as well as that of their deliciousness, they are very dear in the *East-Indies* themselves. The like care to contrive their nests advantageously, and make them in secure places, is taken by divers insects themselves; as may be observed in the subterranean nests of the wasps formerly mentioned, and in the eggs of snails, which I have sometimes found hid under ground, and had the curiosity to hatch in glasses furnished with the same earth they were found in.

IF I should here reckon up and display the several effects, and consequently arguments, of the wonderful providence, that the most wise author of nature exercises about the propagation of animals, by distinguishing them into male and female; by furnishing both sexes with mutual appetites and organs, exquisitely adapted to the increase of their kind; by the admirable formation of the foetus in the womb, without the female's knowledge, how it is performed; by the strange subtilties and courage, that several of them, either oviparous or viviparous, have, to hide and defend their young; by the full provision, that is made for the nourishment of the foetus, and the welfare of the female after she has brought it forth; and by divers other ways, that I must not now stay to specify: if, I say, I should venture to do this, I might indeed much enrich and adorn my argument, but should make this discourse too much exceed the limits, that my design, and small stock either of ability or leisure, would allow. And therefore, instead of pursuing a speculation, that would lead me a great deal too far, I shall look back upon the intimation I gave not long since, that even those meaner parts of animals, which seem to have been framed with the least care or contrivance, are yet not unworthy of their author.

For

For proof of which I shall now observe, that, though the teeth be some of the least elaborate parts of the human body, yet even these afford more observations, applicable to our present purpose, than my intended brevity will permit me to take notice of. And therefore I shall only, and that little more than transiently, consider a few of them here; and some of the others elsewhere, on those particular occasions, on which it will be more proper to bring them in.

I. AND first, it is considerable, that whereas, when a man is come to his full stature, all the other bones of the body cease to grow, the teeth continue to grow in length, during a man's whole life.

THIS growth of the teeth appears, not only by their continuing so many years of the same length, but by the unsightly length of one tooth, when that, which was opposite to it in the other jaw, happening to fall out or be pulled out, the tooth we speak of has liberty to grow into the gap made by the removal of the other. Of this difference in point of growth betwixt the teeth and other bones, what reason can be so probably given, as, that it is designed to repair the waste, that is daily made of the substance of the teeth, by the frequent attritions that are made, between the upper and lower tyre, in mastication?

II. WHEREAS the other bones of the body (some few small ones excepted) are invested with a very thin and sensible membrane, which, for its close adhesion to the bone, is by anatomists called the *periosteum*; that part of each tooth, which is not covered by the gums, has none of this membrane, which would be subject to frequent and very painful compressions and lacerations.

III. To enable the teeth to break, and make comminutions of, the more solid kind of aliments, nature has providently framed them of a closer and harder substance, than almost any other bones of the whole body; though these be so numerous, that anatomists reckon above three hundred of them. And I have met with relations in authors of good credit, that some men's teeth have been so hard, as, when struck with another fit body, to produce sparks of fire.

IV. THAT these bones, whose use (to prepare aliments for nutrition) is so great, and almost necessary, may themselves be continually fed and cherished, though they grow in other bones, the all-wise Author of things has admirably contrived an unseen cavity in each side of the jaw-bone, in which greater channel are lodged an artery, a vein, and a nerve, which thorough lesser cavities, or, as it were, gutters, send their twigs to each particular tooth; which, by these little vessels, that reach to it, receives a continual supply of nourishment and strength.

V. IN regard that babes are, according to nature's institution, to feed for a considerable time on milk, for which there is no need of teeth, and which would also hurt the nipples of her that gives them suck; nature forbears, for many months, to produce teeth in human infants: whereas the foetuses of divers brute animals, that are oftentimes reduced early to seek out aliments, that are not fluid, nor very soft, are born with teeth already formed in their jaws.

VI. THE bony substance, appointed for the comminution of aliments, ought not, for several reasons (which for brevity's sake I here omit) to be in either jaw entire, or all of one piece; and therefore nature has providently made for that use a competent number of distinct bones in either jaw. And because men may often have occasion to feed upon very differing sorts of aliments, and usually the same aliment may require differing preparations in the mouth to facilitate the digestion of it in the stomach; nature has provided men with two rows or sets of teeth, equal for the most part in number, (each jaw in men usually having sixteen, and in women fourteen or fifteen) and answering to each other, but yet of differing shapes, for differing uses. For

some, as the fore-teeth, are broader, and with a kind of edge, to cut the more yielding sort of aliments; whence these teeth are called *incisorii*. Others are stronger, and more fitly shaped to tear the more tough and resisting sort of aliments: these are they, that by the vulgar are in English called eye-teeth, and which, for their resemblance to those of dogs, are by anatomists called *canini*. And then there is a third sort, whose principal office is to grind the aliments, that are cut or torn by the others; and for this purpose they are made much broader, and somewhat flattish, but yet with their upper surfaces uneven and rugged, that by their knobs and little cavities they may the better retain (grind and commix) the aliments, that are to be chewed by them; and for this reason they are called *molares*.

VII. AND because the operations to be performed by the teeth oftentimes require a considerable firmness and strength, partly in the teeth themselves, and partly in the instruments that move the jaw wherein the lower set of them is fixed; nature has provided the lower jaw (which alone is moveable, unless, as some affirm, in crocodiles) with strong muscles, to make it bear forcibly against the upper jaw; and has not only placed each tooth in a distinct cavity of the jaw-bone, as it were in a close, strong, and deep socket, but has furnished the several sorts of teeth with hold-fasts suitable to the stress, that, by reason of their differing offices, they are to be put to. And therefore, whereas the other teeth (the cutters and dog-teeth) have usually but one root, (which in these last named are wont to be very long) the grinders, that on many occasions are employed to crack nuts, bones, or other hard bodies, before they can be ground, are furnished with three roots, and oftentimes with four, in the upper jaw, whose substance is somewhat softer, and whose grinders serve as so many anvils for those of the lower to strike or press against. On which account, as hath been already intimated, the lower jaw (for the other belongs to the immoveable part of the skull) is furnished with a strong muscle on either side, capable of moving it, and consequently the teeth in it, with great force against the upper jaw.

If some favourer of *Epicurus's* doctrine shall here object, that, though man indeed be advantageously furnished with teeth, yet there are many other animals, and even quadrupeds, whereof some have not near so many teeth as man, nor so commodiously shaped and placed as his; and others are not furnished with any teeth at all: and that likewise there are many other animals, that have some of their other parts less convenient in their kind, or otherwise are not near so well provided for, as they would be, if they were not rather casual productions, than those of an intelligent and designing Opificer: if these things, I say, be objected, I must own myself of a very differing opinion from the objector. And I think I could add much about the final causes of things corporeal, as the consideration of them leads to a high veneration of their divine Author, and as it tends to manifest, that, when his providence is denied or condemned, it is for want of its having been sufficiently understood, and duly considered. But besides, that this third proposition ought to be but one part of our discourse of final causes, I have in great part prevented myself already, by what I have formerly said to obviate or answer some exceptions, relating to the eyes of man, and differing animals. For most of the considerations, if not all, that have been alledged on the occasion of those organs of sight, may well be, *mutatis mutandis*, applied to the varieties, that are to be found in the teeth, and other parts, of differing kinds of animals. For I may justly represent, that the reason, why this or that organical part of this or that species of living creatures has not such a structure, or is not so placed, as we might think most convenient, may often be, that in this case it would be less proper for other ends, of more importance to the welfare of the animal, than such a fabric and situation of the part, as we prefer, would be. And there

there are also many cases, wherein the thing, that we make bold to think wanting or amiss, is provided for by other contrivances in the same animal; by which provision the part under consideration is made more serviceable and symmetrical to the rest of the body; and so, performing other offices beside the main, is, upon the whole matter, more useful to the animal, than otherwise it would be.

It is known, that oxen and sheep, and many other ruminating beasts, are not furnished with near so many teeth as men are, and as are to be found in dogs, cats, horses, and many other quadrupeds. But for the paucity of teeth amends is made in most of those animals, partly by the power and instinct they have to chew the cud, and thereby make a second attrition of their already much softened aliments; and partly by the successive cavities or stomachs, (distinguished by the names of *primus venter*, *reticulum*, *omasus* and *abomasus*) through which the aliment is transmitted, and more and more elaborated, to make it fit for further uses. The mouths (especially the inward parts of them) of the beaver, the tortoise, the bee, the humming bird, that feeds on flowers, whose exudations with his long little bill he sucks like the bee: these, I say, and many other animals, (to omit the elephant himself) have their mouth, and their ways of preparing their aliments for the stomach, very different from what is observed in men, and yet very convenient for them respectively, all circumstances considered.

THESE and the like, whether compensations or expedients, are in many animals such, that there is no cause to tax the Author of nature, for not having given some animals all the same parts, that others are furnished with: but rather the thrifty providence (if I may so speak) and designing wisdom of God, in the contrivance of his visible works, may be as well discovered by the seeming omission of this or that part, that is useful to other animals, but is not necessary to those wherein it is not found, as by granting those parts to the animals, to whose compleatness or welfare they are necessary, or highly conducive. On which account it is not to be thought strange, that He has not to men, as to frogs, and many sorts of birds, given such tough, transparent, and moveable membranes, as these animals are provided of to cover their eyes from harms, that those of men are not usually exposed to. And it is not an omission, not to have given girls swelling breasts, before they are capable of generation, more than it is, not to continue to them, after their being grown mothers, the *placenta uterina*, when they are not with child.

THOUGH bats be looked upon as a contemptible sort of creatures, yet I think they may afford us no contemptible argument to our present purpose. For in this heteroclite animal you may discern the fecundity of the divine Artificer's skill, which has in this formed an animal, that flies like birds, and yet is not only unfurnished with feathers, but is of a fabric quite differing from that of other birds. And in this little animal we may also observe, both the compensation, that is made for parts, that seem either deficient, or less advantaged than those of the same denomination in other birds, and the regard, which the divine Artist appears to have to the symmetry of parts in his animated works, and to their fitness for the places they are to live in or frequent. For the bat, being to act sometimes like a bird, that flies freely to and fro in the air, and on some occasions like a terrestrial animal, such as is that little quadruped a mouse, ought to be furnished with parts suitable to such differing destinations: and therefore, to fit him to answer the first of these, the want of feathers in the wings is supplied by a broad membranous expansion, and a kind of toes furnished with articulations, that make up the wings: and because this animal was to be able, like other birds, to forbear settling on the ground, otherwise than his occasions required; each of his wings is furnished with a strong crook, like the claw

of a bird's foot, by the help of which he can fasten himself to trees, walls, and divers other erected bodies, and keep himself suspended in the air, and continue at what distance he pleases from the ground. And because he is furnished with teeth, which other birds want, to chew his food, and thereby prepare it for digestion; he needs not have a crop, or such a strong and muscular stomach, as is usually found in birds. And (in short) to omit the peculiar structure of other internal parts, wherein the batt differs from other birds; since the female was not, like them, to be oviparous, but, like mice and other quadrupeds, that bring forth their young ones alive, she is not only furnished with an uterus fitted for that purpose, but in regard she does not, like birds, that lay eggs, exclude, together with the foetus, a competent stock of aliment to nourish it, till it can shift for itself, the batt is furnished with dugs, to give suck to her young ones: and by Zoographers it is observed, that, as she has but two teats, so she brings forth but two young ones at a birth; whereas mice are much more prolific.

THE writings of Zoographers, and the relations of travellers, afford divers other instances of the various, and yet excellent, contrivances, that are to be found in several animals, that differ from man (who is an animal endowed with numerous teeth) in the fabric of the mouth, and other parts inservient to the reception of aliments, and their preparation for digestion.

BUT passing by the mouths of tortoises, cameleons, and other animals, the hardness of whose gums, in reference to their ordinary aliments, suffices to make amends for their want of teeth; there is one *American* beast, which, I think, I ought not to forbear mentioning here, as a notable instance to manifest, how the wise Architect can compensate the want of teeth, by the rare structure of the mouth and tongue, and their fitness to seize on and make use of those aliments, which, though uncommon for a beast of his bulk, he seems to have been destinated to live upon. The animals of this kind are by *Hernandus*, who retains their *American* names, called *achoas* and *tamendoas*; and of these, and particularly of the parts they are provided

Vid. Scabotti of to eat with, he gives us this account: *Offenduntur apud Yucatenenses quadrupedes*
Phys. Curi- *quidam, dorso præduro & fulvi, agnorum magnitudine, sed qui ventre circiter terram at-*
q. l. 8. c. 5. *tingant, dentium omnino expertes sint, & solo formicarum venatu vivant, quarum cumulos*
duobus magnis unguibus, quibus singuli anteriores pedes armantur, excavant turbantque;
ac dein exerta lingua, quæ dostrante longior est, scabra, teres, ac pennam anserinam crassa,
formicas eam conscendentes ac densantes suscipiunt, eademque contracta, & in os, quod
mirum in modum angustum ac parvum est, recepta, gratum sibi pabulum capiunt, & in-
nocentium animalium præda potiuntur. Of the same sort of beasts, the ingenious *Piso*,
 in his History of *Brasile*, (where he practised physic) mentions two kinds, the greater
 and the less, which he, like *Hernandus*, calls *tamanduas*, but adds the new coined
 name of *myrmechophaga*; and of both gives this account: *Utræque* (says he) *sunt*
noctambule pabuli causa; cicurate carne quoque vescuntur, sed minutim concisa, quia non
solum capite, promuscide, sed & ore sunt angusto, acuminato, edentuloque, lingua deni-
que, instar crassioris chordæ, tereti adeoque longa præsertim: in tamandua majori, ut
duorum pedum longitudinem excedat, atque proinde duplicata (quod notatu sane dignum)
quasi canali incumbit inter inferiores genas, quam esuriens madidam exerit, & arborum
truncis diu imponit, mox formicis opertam repente retrahit. Si alte fodiendo latebræ ea-
rum detegi postulant, unguibus id præstat commode, quibus pedes posteriores instructi sunt
satis validis & longis numero quinque, anteriores quatuor, iisque recurvis duobus in medio
maximis.

It is also to be considered, that divers things may be useful in an organical part, besides that, whereby its function is primarily and mainly exercised: as, though the
 eye-lids

eye-lids and their motions, together with the little glandules, that belong to them, (most of which lye concealed under the edges) are not at all necessary to the act of vision, (no more than curtains are to a window) yet they are to the compleatness and welfare of the eye, which is the necessary organ of vision; as is manifested by the pain and prejudice the eye receives, if the eye-lids, which are subject to more than one distemper, be considerably disaffected.

I MAY hereafter have occasion to take notice, that besides those uses of the parts of a human body, which I venture to call anatomical, because they are such as anatomists have discovered by meer dissections, there may be, of several parts, other uses, which I call chymical, because these parts do elaborate spirits of several sorts, and perhaps exercise some other spagyricall functions of great importance, if not necessary to the welfare of a living man.

AND, besides the anatomical and chymical uses, there may be others very fit to be considered in some parts of a human body; as the mechanical advantages, for which the various shapes and structures of differing muscles, and the seeming irregular (and, as it were, casual) fabric of the bones, and especially of the processes and protuberances, are admirably fitted. And there are also in some parts, as the eyes, optical reasons to be considered, before one can otherwise than rashly censure what the Author of nature has done about them: as, though the figure of the chryselline humour be much more globous in most fishes, than in men and terrestrial animals, yet he, that understands the doctrine of refractions, and considers that fishes, under water, are to see objects through a far thicker medium than air, will readily acknowledge, that this difference between the eyes of fishes and those of men, is not an imperfection in the former; but, whilst those creatures are in their own element, a great advantage. And, to be short, I think there are so many sciences, and other parts of knowledge, some of them perhaps scarce yet discovered, that may be required to warrant a man to censure the ends of God in the bodies of animals, that very few have knowledge enough to be capable of condemning them without rashness: and they, that have knowledge enough to judge aright, will not be forward to condemn them, but admire them. But though this consideration be not here displayed, yet the now mentioned intimation of it may afford us this reflection; that men may easily be too rash, if they think a part bunglingly framed, upon supposition, that, by the anatomical inspection of it, they know all the uses, that the skill of the divine Opificer could design it for.

NOR will it necessarily follow, that because in some particular bird, or beast, or fish, we may not be able to give an account, why this or that part is not to be found, or why it is otherwise framed or situated, than that, which is analogous to it in man, it must therefore be casually or improvidently framed or placed; since we cannot expect, from brute animals, answers to those proper questions about their own bodies, which we can receive from men about their human ones. And yet, notwithstanding the great assiduity, with which the more curious physicians are obliged to cultivate anatomy, and the frequent opportunities they have to do it, and to ask living men questions about what they find, when the natural use of their parts is hindered or perverted; our sagacious moderns are, to this day, at a loss, as to the true uses of the visible parts of the body; to say nothing of the invisible, such as spirits, salts, &c. So that it ought to be no wonder, if in animals, whose fabric we have much less concern to inquire into, and much less opportunity to examine, we sometimes find parts, of whose uses, and their fitness for them, men are not yet able to give a satisfactory account. For I consider, that even in man himself, though there be numerous valves found in his veins, yet for those many ages, that the true uses of them

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lay hid, an *Asclepiades*, or some other bold Epicurean physician, might have thought himself well grounded to look upon them as superfluous parts, which, now that the circulation of the blood is discovered, they are acknowledged to be far from being.

ON this occasion it may help us, if it be considered, that, since God is both a free and a most wise Agent, it need not seem strange, that He should adorn some animals with parts or qualities, that are not necessary to their welfare, but seem designed for their beauty: such as are the disposition of the cameleon to change colours; and the lovely greens, blues, yellows, and other vivid colours, that adorn some sorts of pigeons, and of parrots, and divers lesser birds, as goldfinches, canary-birds, and especially those admirably little winged creatures humming-birds. And, on the other side, sometimes God's wisdom seems to be, as it were, thrifty, and solicitous not to bestow on an animal, or a part of it, more than is necessary for the use, for which it is designed. As the veins are by anatomists observed to have but one coat or membrane, and usually to lye more exposed, than the arteries, that accompany them; these have stronger and double coats, because they are to convey a more important liquor, (the arterial blood) which, besides that it is more agitated and spirituous, is forcibly impelled into those vessels by the muscular contraction, or strong impulse of the heart. And to the same purpose it may be observed, that the arteries within the skull are far more thinly coated than elsewhere; the solidity of that bony part being a fence to the vessels that it covers. And to add, that, on this occasion, we may observe, that though the nerves usually lye deep in the parts, to be kept both safe and warm, being very liable to be offended, both by cold and the contact of external bodies; yet, it being necessary that the optic nerve should expand itself into the eye, the membranes that invest the nerve and other coats of the eye (except the *retina*, which seems to consist of the medullar fibres) are made, by great odds, more firm than the *dura* and the *pia mater*, whence they proceed; and, though exposed to the free air, are less sensible of the cold than most parts of the body, and will bear, without danger, divers liquors, and other offensive things, whose pungency would put other nerves of the body into convulsive (and perhaps very dangerous) motions. This (conduct) looks as if God, like an excellent writing-master, did, in the great volume of his creatures, intend to bestow, on some of these, things rather ornamental than necessary, as flourishes on the capital letters of the alphabet of nature; and sometimes to employ characters, and divers of them very differently shaped, (as the *Latin* are from those of the *Greek*, the *Hebrew*, the *Saxon*, &c.) to express the same letter; and sometimes also to imply abbreviations, as a stroke, or a dash, instead of a letter or a syllable, to express compendiously that, which might be very justifiable, had it been more fully set down or delineated.

If that be admitted, which we have formerly proposed as very likely, that God designed, by the great variety of his works, to display to their intelligent considerers the fecundity (if I may so speak) of his wisdom; one may readily conceive, that a great part of the variety observable in the analogous parts of animals, as their eyes, their mouths, &c. may be very conducive to so reaching and comprehensive a design; to which the beauty of some creatures and parts, as well as their more necessary or convenient structure, may be subservient; especially if the innocent delight of man be also intended, as it may seem to be in the curious colours and shapes of divers flowers, and in the melodious music of singing birds, and in the vivid and curiously variegated colours of the feathers of several winged animals, particularly those that make up the peacock's train.

WE are not near so competent judges of wisdom, as we are of justice and veracity; for these last named are to be estimated by external and fixed bounds or rules, which

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are very intelligible to a moderate understanding: but as for wisdom, the more profound it is, the less we are able to look through it, and penetrating to the bottom of that, to judge knowingly of its actions. And therefore, though we may safely conclude, that God acts wisely, when He does something that has an admirable tendency to those ends we justly suppose Him to have designed; yet we cannot safely conclude, in a negative way, that this or that is unwise, because we cannot discern in it such a tendency. For so wise an Agent may have other designs than we know of, and further aims than we can discern, or perhaps suspect; and may have at hand, or furnish Himself with, such means to compass his ends, and that even by the co-operation of those means we think useless or improper, as far as above the reach of our conjectures, and without the knowledge of which we but rashly censure the wisdom of his proceedings.

IN the double horizontal dial, formerly mentioned, it would be rashly done of those, who should condemn or despise the various lines, they find traced upon that useful instrument, because they see, that they are not necessary to shew the hour of the day; since the mathematician, that drew those lines so curiously, may be well supposed to have more ends than one or two in making the instrument, and not to have drawn them by chance or unskilfully, though the inconsiderate censurers do not know, for what other or further purposes the artist may have designed them.

SUPPOSE some Indian fisherman, unacquainted with European arts and affairs, should happen to come aboard a man of war under sail; though he would quickly perceive, by the use that was made of the ropes, pully, &c. that this floating building was very artificially contrived; yet if he should fix his eyes upon one of the guns, and the anchors, and perceive that no use was made, nor like to be made, of them in sailing, he would be strongly tempted to think, that those heavy masses were useless clogs and burdens to the vessel: but if he were told the necessity and usefulness of the guns for defence, and of the anchors to stay the ship in convenient places in storms, he would easily alter his mind, and confess, that he blamed the builders and furnishers of the ship, for that, which nothing but his ignorance kept him from highly commending.

I HAVE dwelt much longer than I intended on this third proposition, because I think it a duty our reason owes to its Author, to endeavour to vindicate his manifold wisdom, in this libertine age; wherein too many men, that have more wit than philosophy or piety, have, upon Epicurean (and some also even upon Cartesian) principles, laboured to depreciate the wisdom of God, and some of them presumed to censure the contrivances of these living *automata*, that (in their protoplasts) were originally his. And it was not only the reasonableness of saying, about so important a subject, some things, that possibly have not yet been met with, or at least duly considered, that has made me thus prolix; but a desire, that my reader should not barely observe the wisdom of God, but be, in some measure, affectively convinced of it. To which purpose, in my opinion, it is very conducive, if not necessary, besides general notions, to observe, with attention, some particular instances of the divine skill, wherein it is conspicuously displayed. It is true, that, in the idea of a Being infinitely perfect, boundless wisdom is one of the attributes that is included: but, for my part, I shall take leave to think, that this general and indefinite idea of the divine wisdom, will not give us so great a wonder and veneration for it, as may be produced in our minds, by knowing and considering the admirable contrivance of the particular productions of that immense wisdom, and their exquisite fitness for those ends and uses, to which they appear to have been destinated.

PROPOSITION IV.

That we be not over-hasty in concluding, nor too positive in asserting, that this or that must be, or is, the particular destined use of such a thing, or the motive, that induced the Author of nature to frame it thus.

IT has been above declared, that some parts are so excellently and so manifestly fitted for a certain use, as the eye for seeing; and so much better fitted for that, than for any other; that it were little less than heedlessness or perverseness, to doubt of its being destined thereto. But the like cannot be said of all the other parts of the body, especially of the internal. And there are divers uses, either necessary, or highly conducive, to the welfare of the animal, to which no one part is so much more conspicuously fitted than any other, but that it is more difficult than many think, to determine the true and primary uses or offices of some parts, especially with so much certainty, as thereon to ground physiological inferences: and of this difficulty I conceive there may be four reasons, though they do not all, nor perhaps most of them, occur in each particular case.

AND first, the whole animal itself, the use of whose particular parts is under inquiry, is but a part of that greater body, the universe; and therefore cannot easily be supposed to have been framed and furnished with the parts it consists of, merely for its own sake. And when we say, that all its parts are contrived for the best advantage for the animal, I conceive it to be understood in this limited sense; that the parts are excellently framed for the welfare of the animal, as far forth, as that welfare is consistent with the general ends of the Author of nature, in the constitution and government of the universe; which ends, because they relate to the whole world, or to very considerable masses of it, as the terraqueous globe, the planets and other stars, I have formerly, for brevity's sake, stiled cosmical: and though it has not been proved, that none of these cosmical ends are investigable by us, yet to discover them all, is not an easy task. And yet it seems presumptuous to suppose, that the welfare of particular animals is any further designed and provided for, than will consist with the cosmical ends of the universe, and the course of God's general providence, to which his special or particular providence, about this or that mere animal, ought in reason to be subordinatèd. And though I think it a great rashness for us men to determine positively, and exclusively to others, what ends the omniscient Creator proposed to Himself, in giving to the world the frame we see it has; yet, as far as I can hitherto discern, I see nothing, that is more likely to have been one grand motive of so great a variety, as we may observe in his corporeal works, especially in animals, than that which hath in part been elsewhere intimated, *viz.* that He might, by so many and so very differing contrivances, as are to be met with in the structure of men, four-footed beasts, birds, fishes, reptiles, &c. exercise and display (what could not be by a less variety so fully manifested) that, which an apostle, speaking

Eph.iii.10.

of things of another order, emphatically stiles the πολυποίκιλον & σοφία τοῦ Θεοῦ (the multifarious or manifold wisdom of God.) Man being acknowledged, upon the account of his very body, the most perfect of animals, if God had simply designed the giving of every animal the most advantageous structure, that could be devised, it seems, that He should have made no other animals than men. But then there could not have been that diversity of contrivance among living *automata*, that does so much recommend the wisdom of Him, that could frame so many and so differing animals, though not all of them equally perfect, yet all of them admirably furnished

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for those purposes to which He destinated them. And therefore it does not argue any want of providence, that He has not furnished man with wings, as He hath birds; nor fishes with four feet; nor birds with fins and scales; because these parts would have been either superfluous and burthensome, or would not have suited with his design, of making some animals live on the earth, and some in the water: and if he designed any to live, though not equally, in both, he furnished them with parts of a peculiar structure, as I have elsewhere noted of the beaver and the frog. If it were not for the fore-mentioned consideration, it would be hard to give a reason, why vegetables were not made the food of all animals; but some should be carnivorous, and furnished with appetites and organs to devour others, and live as birds and beasts of prey do, upon the destruction of the weaker. And it will be hard to shew, why, even in animals of the same kind, the safety of some should be so much better provided for, than that of others; as we see, that some ants, and some glow-worms, are furnished with wings, and some not. And in mankind itself, those of the female sex are not so happily framed, in order to their own welfare, as those of the masculine: since the womb, and other things peculiar to women, which are not necessary to the good of individual persons, but to the propagation of their species, subject that tender sex to a whole set of diseases, belonging to them either peculiarly as they are women, or as they are with child, or brought to-bed; from all which men are exempt. So that, to apply these things to our present purpose, men may sometimes mistake, when they peremptorily conclude, that this or that part of an animal must, or cannot have been framed for such an use, without considering the cosmical, and therefore primary and over-ruling ends, that may have been designed by nature in the construction of the whole animal.

SECONDLY, men sometimes erroneously conclude, that such an office cannot belong to such a part, because they think it is not so commodiously framed for it, as may be wished or devised; without considering, whether the structure, which they fancy would do better for that particular use, would not, in some other as considerable regard, oppose the welfare of the animal; or, whether it would be consistent with the other uses designed by nature in that sort of living creatures. For in the living works of so excellent an engineer as nature, it must not be expected, that any particular end should be prosecuted to the prejudice of the whole; but rather it must be supposed, that she aims not only at particular expedients, but universal symmetry; and does indeed excellently fit the several parts for their respective offices, but yet only as far forth, as a due regard to the design and welfare of the whole will permit. The reasonableness of this observation, one need but be moderately exercised in zootomy (as that is distinguished from androtomy) to discern. For though man be confessed to be the most perfectly framed animal in the world, yet his body is not made the model, on which nature has framed the correspondent parts of other animals. The lungs of dogs, of birds, of frogs and vipers, and I know not how many others, are of a structure very differing from those of man. He is not furnished with so many stomachs as an ox or a sheep, because nature intended not he should ruminate like them. Though his gall be lodged in a peculiar bag, so placed in the liver, as to give *Helmont* a colour to call it *nucleus hepatis*, yet it were unadvised to say, that the secretion of gall is none of the uses of those livers, wherein such a cystis is not to be met with; since in some animals, as in horses and pigeons, that bitter humour, (which in frogs I have often observed to be of a deep and transparent green) is not usually, as in man, collected into one bag; and in vipers, though it be included in one cystis, yet, as far as I have observed, that bag does

not at all touch the liver: and store of such instances may be met with among the remarks of zootomists: wherefore I pass on to observe,

THAT, in the third place, it is difficult to determine the true and primary use of a part, because nature does often fit one part for several uses. To which I shall add,

In the fourth place, that the difficulty is sometimes increased, because nature may compass the same end by several means, each of them sufficiently, though not equally commodious. I join these two together; because, in effect, they do often concur in making it difficult to determine the true use of a part. And the latter of these two is sometimes increased by this, that nature does not as constantly, as some men presume she does, employ only one part to perform such an office; but the intended effect is sometimes produced, by a series of successive operations, to which several parts may, in differing manners, contribute.

AND here I observe, (what perhaps has not been considered) that neither the mechanism of a human body, nor that of very considerable parts of it, is to be judged of only by the structure of the visible parts, whether they be those solid or stable ones, that the anatomist's knife is wont to expose to sight; or even by the texture of those fluid ones, which are to be found in the vessels and cavities of a dead body, when dissected, though never so skilfully. For I take the body of a living man to be a very compounded engine, such as mechanicians would call *hydraulico-pneumatical*; many of whose functions, (if not the chiefest,) are performed, not by the blood and other visible fluids barely as they are liquors, but partly by their circulating and other motions, and partly by a very agile and invisible sort of fluids, called spirits, vital and animal, and partly perhaps, (as I have sometimes guessed) by little springy particles; and perhaps too, by somewhat, that may be called the vital portion of the air; and by things analogous to local ferments; the important operations of all which are wont to cease with life, and the agents themselves are not to be discerned in a dead body. So that besides these manifest uses, which the visible fabric of the engine may suggest to an anatomist, there may be chymical uses (if I may so call them) of some parts, that serve for the elaboration of spirits and other fluids: which uses, (as it was formerly observed, and yet ought to be inculcated) are not suggested to the anatomists, as such, by the inspection of the structure of the parts; but to discern them may require no mean skill in spagyric principles and operations.

Such considerations as the foregoing make me think it more difficult than many do, to determine, with any certainty, the main use of divers particular parts, [for in some others it seems manifest enough;] especially if it be done with the exclusion of other uses. Nor is it enough to secure us, that we know the chief function and end of a part, to know, that is contrived for such a purpose: for upon the things I have lately represented, one may ground this answer, that this fitness hinders not, but that the primary use of the part may be another, (as not anatomical, but chymical, or *vice versa*) more conducive to the general welfare of the animal, or else to the cosmical ends of nature. And it ought not to seem strange, that some pieces of workmanship, that consist of many parts, all of them curiously contrived, may by one learned man be guessed to be intended for this use, and by others for that use; and yet both these uses may be worthy of the artificer.

WHEN some very politic prince does some great thing, without declaring why, the guesses of the statesmen are often very differing, whilst yet none of them ascribe to him a design mis-becoming a wise man. And so, when a learned author expresses himself, as sometimes it happens, ambiguously, though one reader interprets his

his words to this sense, another to that, yet both the senses pitched upon may fairly comport with the context, and the main scope of the writer. These things I say, because I would by no means disparage the wisdom of nature, by proposing the difficulties I have hitherto mentioned; though I confess, that, upon the account of these and some others, I look upon many of the arguments, that several authors have made bold to draw from final causes, but as conjectural things. And in divers cases I allow what is suggested to me upon the supposition of the intended uses of particular parts, rather as good hints to excite, and give some aim to, a severer inquiry, than as safe grounds to build physical conclusions on.

I now come to the last caution I would recommend to you, about the consideration of *Final Causes*; and I shall present it you in the following proposition.

PROPOSITION V.

That the naturalist should not suffer the search, or the discovery of a Final Cause of Nature's works, to make him under-value or neglect the studious indagation of their efficient causes.

IT is true, that to inquire to what purpose nature would have such or such effects produced, is a curiosity worthy of a rational creature, upon the score of his being so: but this is not the proper task of a naturalist, whose work, as he is such, is not so much to discover, why, as how, particular effects are produced. A country-fellow here in *England* knows something of a watch, because he is able to tell you, that it is an instrument, that an artificer made to measure time by; and that is more than every American savage would be able to tell you; and more than those civilized Chineses knew, that took the first watch the Jesuits brought thither for a living creature. But the English countryman, that knows no more of a watch, than that it was made to shew the hour of the day, does very little understand the nature of it. And whereas the two scopes, that men are wont to aim at in the study of physics, are to understand how, and after what manner nature produces the phenomena we contemplate; and, in case it be imitable by us, how we may, if occasion require, produce the like effect, or come as near it as may be; these ends cannot be attained by the bare knowledge of the final causes of things, nor of the general efficient: but to answer those aims, we must know the particular efficient, and the manner and progress of their operating, and what dispositions they either find or produce in the matter they work upon. As he, that would thoroughly understand the nature of a watch, must not rest satisfied with knowing in general, that a man made it, and that he made it for such uses; but he must particularly know, of what materials the spring, the wheels, the string or chain, and the balance are made: he must know the number of the wheels, their bigness, their shape, their situation and connexion in the engine, and after what manner one part moves the other in the whole series of motions, from the expansive endeavour of the spring to the motion of the index, that points at the hours. And much more must a mechanic know this, if he means to be able to make a watch himself, or give sufficient instructions to another man, that is more handy to do it for him. In short, the neglect of efficient causes would render physiology useless; but the studious indagation of them will not prejudice the contemplation of final causes: for, since it is truly said, if it be rightly understood, that *opus naturæ est opus intelligentiæ*, the wise Author of nature has so excellently contrived the universe, that the more clearly and particularly we discern, how congruous the means are to the ends to be obtained

Isa. xx.
29.

by them, the more plainly we discern the admirable wisdom of the omniscient Author of things; of whom it is truly said by a prophet, that *he is wonderful in counsel, and excellent in working*. Nor will the sufficiency of the intermediate causes make it needless to admit a first and supreme cause; since (to inculcate, on this occasion, what I more fully deliver in another paper) that order of things, by virtue of which these means become sufficient to such ends, must have been at first instituted by an intelligent cause. And if it be irrational to ascribe the excellent fabric of the universe, such as it now is, and the actions, that have manifest tendencies to determinate useful ends, to so blind a cause as chance; it will be rather more than less irrational, to ascribe to chance the first formation of the universe, of which the present state of things is but the natural consequence or effect: for it may indeed be plausibly said, that, in the present state of things, the several parts of the universe are, by the contrivance of the whole, determined, and thereby qualified to attain their ends. But it cannot be rationally pretended, that at the first framing of the world, there was a sufficiency in the stupid materials of it, without any particular guidance of a most wise Superintendent, to frame bodies so excellently contrived and fitted to their respective ends.

The CONCLUSION.

THE result of what has been hitherto discoursed, upon the four questions proposed at the beginning of this small treatise, amounts in short to this:

THAT all consideration of final causes is not to be banished from natural philosophy; but that it is rather allowable, and in some cases commendable, to observe and argue from the manifest uses of things, that the author of nature pre-ordained those ends and uses.

THAT the sun, moon, and other celestial bodies, excellently declare the power and wisdom, and consequently the glory of God; and were some of them, among other purposes, made to be serviceable to man.

THAT from the supposed ends of inanimate bodies, whether celestial or sublunary, it is very unsafe to draw arguments to prove the particular nature of those bodies, or the true system of the universe.

THAT as to animals, and the more perfect sorts of vegetables, it is warrantable, not presumptuous, to say, that such and such parts were pre-ordained to such and such uses, relating to the welfare of the animal (or plant) itself, or the species it belongs to: but that such arguments may easily deceive, if those, that frame them, are not very cautious, and careful to avoid mistaking, among the various ends, that nature may have in the contrivance of an animal's body, and the various ways, which she may successfully take to compass the same ends. And,

THAT, however, a naturalist, who would deserve that name, must not let the search or knowledge of final causes make him neglect the industrious indagation of efficient.

SOME UNCOMMON
OBSERVATIONS
ABOUT
VITIATED SIGHT.

ADVERTISEMENT.

THE following observations were not written with intention, that they should be annexed to the foregoing essay, but to gratify a philosophical physician: which is the reason, why, besides those things, that are more purely optical, I thought fit to mention some others, that might be either useful or grateful to an inquisitive man of his profession. But having allowed the stationer to expect, that this book, though it have for title but an essay, should not be of too inconsiderable a bulk, I made choice of these papers, among several, that lay by me, to increase the bigness of the book; because that the eyes being those parts of the bodies of men and other animals, that I pitched upon in the foregoing treatise to strengthen the doctrine delivered in it about final causes, it seemed suitable enough to my subject and design, to mention some uncommon things, that related to vision or the organs of it, that we may be invited both to admire the wisdom of God, which, to furnish man with a sense, that requires the concurrence of so very many things, has, if I may so speak, crowded them into so small an engine as an eye; and to celebrate his goodness too, which has been displayed in that, notwithstanding that the eye is so very compounded a part, and the sight so easily vitiated, yet the most part of men by far do, from their cradles to their graves, enjoy the benefit and comfort of so necessary and noble a sense.

OBSERVATIONS about VITIATED SIGHT.

OBSERVATION I.

EXAMINING a gentleman, that was already almost blind, and feared to grow altogether so, about the symptoms of his disease, (which came with a stroke upon his head,) I found as I expected, by his answers, that, though he could not any thing well distinguish objects of other colours, yet he could well perceive those, that were white, to be of that colour: which confirms what I mention in the history of colours, concerning the great quantity of light, that is reflected by white objects, in comparison of those, that are otherwise coloured. And

this observation itself was confirmed by another patient, who, though almost blind, could yet discern white objects.

OBSERVATION II.

I KNEW a gentleman that had a cataract growing, which, when I looked on his eye in a lightsome place, appeared to cover almost just the upper part of the pupil; and though he were a young vigorous person, and the weather was very clear, he could not well discern men from women cross the street. But this gentleman's misfortune came by a great stroke he received on that side of his head, whereof he shewed me the scar; which circumstance I therefore note, because when no outward violence has been offered to the eye, it has been observed by a good oculist, and, if I misremember not, I have seen an instance of it, that a small part of the pupil, left uncovered by the cataract, would serve for more sight than the gentleman enjoyed. In him likewise I had a further confirmation of what I was lately observing about the conspicuousness of white objects: for though he could not, as I was saying, discern men and women, that passed by on the other side of the street, yet having once desired him to tell me, if he could distinguish any object there, he told me that he could; and that I might no longer doubt of it, when I asked him what he saw, he said, that it was a woman, that passed by with a white apron; which apron he saw directly, and therefore might easily conclude, without distinctly seeing the wearer, that the person, that wore it, was a woman.

OBSERVATION III.

MEETING accidentally with a man, by profession a farrier, whose eyes looked very oddly, I questioned him about his distemper; and found by his answers, that he had had cataracts in both his eyes, but either had them ill couched, or had not behaved himself orderly afterwards: for there seemed still to be ragged films, that covered considerable portions of his pupils; insomuch, that I somewhat wondered to see him go freely about, as he did, without requiring any body to help him, so much as up or down stairs: and I hereupon asking him, whether he were able to read in a large print, he told me he was, with the help of his cataract spectacles, as they call them; which I doubting of, brought him a book, whose title page he was not able to read. This he excused by saying, that the place was too lightsome, which though it did not seem to others, yet considering, that it was about noon, I caused the room to be a little darkened, and then perceived, that indeed he could read well enough.

OBSERVATION IV.

A GENTLEMAN, having in a quarrel received a stroke on one side of his head, which knocked him down, found afterwards a great weakness and dimness in his eyes; into which when I looked attentively, I plainly discerned, that though above one half of his pupil was yet uncovered, so that, when he looked downwards, he could see well enough with that eye, yet there was grown in it no less than two cataracts, which, when I looked on them attentively, and in a good light, I could manifestly perceive to be distinct; the one of them seeming to be smooth spread, as if its circular edge adhered closely to the inside of the eye; and the other, that seemed not altogether of the same colour, hanging loosely, and as it were a rag, at
some

some distance above it. What afterwards became of this gentleman I could not learn, though I would gladly have done it; two cataracts at a time in one eye being somewhat extraordinary.

OBSERVATION V.

A LEARNED gentleman coming once to visit me, with design, as I afterwards perceived, to hear my opinion concerning an odd distemper he had in his eyes; I found by discoursing with him concerning the phænomena of his disease, that though, when he looked on objects near at hand, he saw them somewhat dimly, but yet single, yet there were some objects, particularly posts and rails, which, when he beheld at a certain distance (which was not very great) they appeared to him both more dark and double. I found also, that he complained of divers black flies and little leaves, that passed now and then before his eyes; which though they do not always forebode a true cataract, since others and I also have observed them to continue many years, without being more than a bastard suffusion (as physicians speak) yet in him they were probably forerunners of a true cataract; in regard that I have known it observed by a skilful oculist, that some persons, before their cataract, have complained, that at some distances they saw objects almost double; so that looking at one's head, they thought they saw a great part of a dark head a little above it: which description, whether it proceeded from some refractions made by the yet not uniformly opacous matter of the cataract, not having opportunity to examine those persons myself, I dare not venture to say.

OBSERVATION VI.

It may be worth observing, how long the better sort of cataracts, tho' they hinder sight for a time, as a thick curtain drawn cross the pupil, yet may remain in the eye, without spoiling the optic nerve or hindering vision, when once the cataract is removed; of which I remember, among other instances, I took notice in the case of a woman, who told me she had cataracts in her eyes so long, that she was brought to-bed of six children consecutively, without being able to see any one of them, till after she was cured by having the cataracts couched. But then she saw so well, that with spectacles she could read in a portable bible of a small print. And divers considerable persons of my acquaintance saw one of eighteen years old, born with cataracts in both her eyes, who not naturally wanting the faculty of seeing, though thus hindered of the exercise of it, had been so happily couched, as afterwards to have the benefit of sight in them both.

OBSERVATION VII.

It has been of late the opinion of very learned men, that though both our eyes be open and turned towards an object, yet it is but one of them at a time, that is effectually employed in giving us the representation of it. Which opinion, in this place, where I am writing but observations, it were not proper to discuss; especially because what is supposed to be observed, will not always uniformly happen, but may much vary in particular persons, according to their several customs, and the constitution of their eyes. For I have, by an experiment purposely made, several times found, that my two eyes together see an object in another situation, than either of them apart would do. On the other side, I met with a person, who told me he had

had a cataract in his eye for two years, without discerning, that he had any such impediment in either of his eyes; and when I asked him, how he knew that, he answered me, that others had taken notice of a white film, that crossed his eye, so long before he himself did; but not knowing what a cataract was, and not finding him to complain of it at all himself, the thing remained unheeded, till the patient having one day occasion to rub his sound eye, whilst the lid covered it, was sadly surprized to find himself altogether in the dark; and then resorting to an oculist, was assured it was a cataract, which, a while before I met with him, had been couched. But notwithstanding this relation, what I had tried about the using of both eyes, made me ask of a very ingenious person, that by an accident had some months before one of his eyes struck out, whether he did not observe, that upon the being confined to the use of one eye, he was apt to mistake the situation and distances of things. To which he answered me, that having frequently occasion to pour distilled waters and other liquors out of one vial into another, after this accident he often spilt his liquors, by pouring quite beside the necks of the vials he thought he was pouring them directly into. Afterwards inquiring of a gentleman, that was a good fellow, and had by a wound a while before lost the use of one of his eyes, he confessed to me, that divers times pouring the wine out of one vessel into another, he would miss the orifice of the bottle or glass, that should receive it, and expose himself to the merriment of the company. A yet more considerable instance of such mistakes I afterwards had from a noble person, who having in a fight, where he played the hero, had one of his eyes strangely shot out, by a musket-bullet, that came out at his mouth, answered me, that not only he could not well pour drink out of one vessel into another, but had broken many glasses, by letting them fall out of his hand, when he thought he had put them into another's, or set them down upon a table: and he added, that this aptness to misjudge of distances and situations continued with him, though not in the same degree, for little less than two years. But on this occasion I shall take notice, that I have often employed a dextrous artificer, whose right eye (for in his left there is nothing more remarkable) is constantly drawn so much aside towards the greater angle of the eye, that the edge of the pupil does almost touch it, and one would think it scarce possible, but that he should see the object double with two eyes, that seem so very differently turned; and yet he answered me, that he does not see at all, nor that he finds any inconvenience, save the deformity of this unusual situation of his right eye, which hinders him not from reading freely as other men. This accident happened to him by an unwary mistake of sublimate for another thing; after which, it seems one of the muscles, that moved the eye, remained contracted: but this having happened to him, as I found by inquiry, ever since he was two years of age, he could not remember, whether he had seen objects double, before he was accustomed to judge of them by the help of his other senses, and the information of others.

OBSERVATION VIII.

It may be worth while to observe, that a very great distention may be made of the parts of the eye, without spoiling the sight; of which I lately saw an instance in a patient of that ingenious and experienced oculist, Dr. *Turbervill*. This was a gentlewoman of about one or two and twenty years of age, whose complexion and features would have made her handsome, if she had not had that sort of eyes, which, though rarely met with, some call ox-eyes; for hers were swelled much beyond the size of human eyes, insomuch, that she complained they often frightened those, that

that saw her, and were indeed so big, that she could not move them to the right hand or the left, but was constrained to look straight forward; or if she would see an object, that lay aside, she was obliged to turn her whole head that way. And so she answered me she was, when she set herself to read in a book, unless she did with her hand move the book from one side to another, to bring the ends of the lines directly before her eyes. She told me her eyes did not always retain the same measure of tumidness, and that the very day I saw them, they had been in the morning much more swelled, than when I looked upon her. But that, which was more remarkable, was, that not only she could, for all this, see very well and distinctly, and, as I just now intimated, could read books, but her sight had continued good, though she had this distemper these twelve years. And, which is more strange, she answered me, that her visive power was so little prejudiced by this distemper, when it first came upon her, that she never knew any thing was amiss in her eyes, till her friends told her of it, when they found it had continued too long to be a merely casual and transient tumor. But though this odd accident did not impair her sight, it occasioned great pains in her eyes, for which she took purging and other medicines with so little success, that both she and her former physicians thought her case desperate, there appearing no way of dislodging a humour so long settled there. Upon which I proposed salivation, as the least unlikely way, that remained, to resolve and carry off the peccant humour: but this, though much approved by her doctor, the modest patient would by no means consent to.

OBSERVATION IX.

I ONCE looked into the eyes of a gentlewoman, where I could discern nothing, that was amiss, or any thing, that was unusual, save the narrowness of her pupils, which is often esteemed a good sign; and yet this woman was much troubled with fumes and weaknesses of the head, and had a disaffection of sight very uncommon; for she told me, that, whereas in the day time her sight was so dim, that she could hardly discern her way, soon after sun-set, and during the twilight, she could discern things far better: and in this condition she had continued a good while. In which odd case, whether the smallness of her pupils, which might possibly be contracted too much by the day-light, and might be expanded by the recess of so much light; or the greater dissipation of the visive spirits at one time than at the other, may have any interest, I shall not now stay to inquire. But this patient brings into my mind the rare case of a learned old divine, who complained to me, that he was forced to write his letters and books by night, because, during the day-time, his right hand shook so much, that he could not manage a pen, and therefore was forced to make use of it only by candle-light. And I remember, that, upon his pressing me to propose some possible cause of so odd a phenomenon, I told him, to put him off, that perchance the few animal spirits, that he had to move his hands with, were so subtle, as to be dissipated or exhaled by the warmth of the day, but were kept in by the coldness of the night, that somewhat constricted his pores; and commended to him the use of strengthening things, and, among the rest, of chocolate; which when for some time he had continued to drink, he came to me, and told me with joy, that he began again to be able to write in the day, and so I think he can do yet. But this upon the by.

OBSERVATION X.

BEING acquainted with two ladies of very distant ages, but very near of kin, who were both of them troubled with distempers, that made me guess their eyes might sometimes be oddly affected, I inquired of them, whether they were not troubled with sudden apparitions of flame or fire? to which one of them answered me, that oftentimes there would appear to her multitudes, as she fancied, of sparks of fire, that were very unwelcome to her. And the other lady, that was subject to convulsive, but not epileptic, fits, told me, she divers times saw, as she fancied, such flashes of fire, as I had mentioned, pass before her eyes, which at first did not a little frighten her.

OBSERVATION XI.

THE following observation is odd enough, to give rise to some curious speculations and disputes; and therefore I chose to set it down as I found it among my *adversaria*, though I suspect part of it to have been lost, that the relation may be the more unbiassed, though, if I had another opportunity to discourse with the patient, I should, upon second thoughts, have asked some questions, and written down some circumstances, that I now wish had not been omitted.

THE gentlewoman, I saw to-day, seems to be about eighteen or twenty years old, and is of a fine complexion, accompanied with good features. Looking into her eyes, which are grey, I could not discern any thing, that was unusual or amiss; though her eye-lids were somewhat red, whether from heat, or, which seemed more likely, from her precedent weeping. During the very little time, that the company allowed me to speak with her, the questions I proposed to her were answered to this effect:

THAT about five years ago, having been, upon a certain occasion, immoderately tormented with blisters, applied to her neck and other parts, she was quite deprived of her sight.

THAT some time after she began to perceive the light, but nothing by the help of it: that then she could see a window, without discerning the panes or the bars: that afterwards she grew able to distinguish the shapes of bodies, and some of their colours: and at last she came to be able to see the minutest object; which when I seemed to doubt of, and presented her a book, she not only without hesitancy read in it a line or two, (for her eyes are quickly weary) but having pointed with my finger at a part of the margin, near which there was the part of a very little speck, that might almost be covered with the point of a pin, she not only readily enough found it out, but shewed me, at some distance off, another speck, that was yet more minute, and required a sharp sight to discern it. And yet, whereas this was done about noon, she told me, that she could see much better in the evening, than in any lighter time of the day.

WHILE she was looking upon the printed paper I shewed her, I asked her, whether it did not appear white to her, and the letters black? to which she answered, that they did so; but that she saw, as it were, a white glass laid over both the objects. But the things, that were most particular and odd in this woman's case, were these two. The first is, that she is not unfrequently troubled with flashes of lightning, that seem to issue out like flames about the external angle of her eye, which often make her start, and put her into frights and melancholy thoughts. But the other, which is more strange and singular, is this, that she can distinguish some colours,

as

as black and white; but is not able to distinguish others, especially red and green; and when I brought her a bag of a fine and glossy red, with tufts of sky-coloured silk, she looked attentively upon it, but told me, that to her it did not seem red, but of another colour, which one would guess by her description to be a dark or dirty one: and the tufts of silk, that were finely coloured, she took in her hand, and told me they seemed to be a light colour, but could not tell me which; only she compared it to the colour of the filken stuff of the laced petticoat of a lady, that brought her to me; and indeed the blues were very much alike. And when I asked her, whether in the evenings, when she went abroad to walk in the fields, which she much delighted to do, the meadows did not appear to her cloathed in green? she told me they did not, but seemed to be of an odd darkish colour; and added, that when she had a mind to gather violets, though she kneeled in that place where they grew, she was not able to distinguish them by the colour from the neighbouring grass, but only by the shape, or by feeling them. And the lady, that was with her, took thence occasion to tell me, that when she looks upon a Turkey carpet, she cannot distinguish the colours, unless of those parts that are white or black. I asked the lady, whether she were not troubled with female obstructions? to which she answered me, she was not now, but that formerly she had been much subject to them, having been obstinately troubled with the green-sickness.

OBSERVATION XII.

I SHALL add on this occasion something, that, though not so odd as it, has yet an affinity with the newly recited case, and so may make it the more credible. And it is, that I lately conversed with a mathematician, eminent for his skill in optics, and therefore a very competent relater of phænomena belonging to that science, whose organs of vision are so constituted, that though in his eyes I could discern nothing amiss, and though he makes much and excellent use of them in astronomical observations and optical experiments, yet he confesses to me, that there are some colours, that he constantly sees amiss, and particularly instanced in one, which in a clear day (for so it was when we discoursed together of this matter) seemed to him to be the same with that of a darkish sort of cloth, that he then wore, whilst to me and other men it appeared of a quite differing colour.

OBSERVATION XIII.

DISCOURSING with a lady, who had been very long troubled with a very unusual indisposition in her head, and, though she looks well, is never without pain in it; though, looking into her eyes, I perceived nothing amiss, yet, conjecturing that so obstinate a distemper must have had some unusual influence upon her sight, I learned by inquiry, that, after the violent fits of pain and disorder she had from time to time in her head, if she did but cast her eyes, or turn them suddenly, from one side to the other, there would presently ensue a convulsive motion in one of them, whereby it would not only be drawn away, but, which was very strange, all white things, and most other objects, that she looked on; with that eye, appeared green to her: and yet this was not a transient discomposure, that would go quickly off, but would molest her for a good while, and frequently returned upon her for a whole year; so that she despaired of recovering the use of that eye, wherewith yet she now sees very well, though her cephalic distempers were rather mitigated than quite cured. And when I asked her, whether, whilst the convulsion of her eye lasted, she did not see

objects double? she answered, that, whilst that distemper was upon her, if she went to read in a book, the letters were so apt to appear double, that, when she was bent upon reading, she was fain to shut the distempered eye, and employ only the other.

OBSERVATION XIV.

SOME may think, that a man has rather an excellent (than a vitiated) sight, who can see objects with a far less degree of light, than other men have need of to discern them. But though an extraordinary tenderness may be a kind of perfection in the eyes of bats and owls, whose usual food may be more easily purchased by twilight; yet as to man, the main part of whose actions is to be performed by the light of the day, or some other almost equivalent, it may argue the provident goodness of the Author of nature, to have given him eyes constituted as those of men generally are: since that a very great tenderness of the *retina*, or principal part of the organ of sight, would be, if not an imperfection, at least a great inconvenience, may appear by the memorable story I am going to relate.

IN the army of the late King, of happy memory, (*Charles* the first) there was a gentleman of great courage and good parts, that was major to one of the regiments; who being afterwards by the prevailing Usurpers forced to seek his fortune abroad, ventured to do his King a piece of service at *Madrid*, which was of an extraordinary nature and consequence, and there judged very irregular. Upon this he was committed to an uncommon prison, which, though otherwise tolerable enough, had no window at all belonging to it, but a hole in the thickness of the wall, at which the keeper once or twice a day put in liberal provision of victuals and wine, and presently closed the window, if it may be so called, on the outside, but not perhaps very solicitously. For some weeks this poor gentleman continued in the dark, very disconsolate: but afterwards he began to think he saw some little glimmering of light, which from time to time increased; insomuch, that he could not only discover the parts of his bed, and other such large objects, but at length came to discover things so minute, that he could perceive the mice, that frequented his chamber, to eat the crumbs of bread, that fell upon the ground, and discern their motions very well. Several other effects of his sight in that dark place he related. And that, which confirms, that this proceeded mainly from the great tenderness the visive organ had acquired by so long a stay in so obscure a place, was, that when after some months, the face of affairs abroad being somewhat changed, his liberty was restored him, he durst not leave his prison abruptly, for fear of losing his sight by the dazzling light of the day; and therefore was fain to accustom his eyes by slow degrees to the light. This strange (as well as once famous) story, I the less scruple to set down in this place, because I had the curiosity to learn it from the gentleman's own mouth, who acquainted me with other particulars about it, that, for want of the notes I then took, I shall not now venture to speak of.

M E D I C I N A H Y D R O S T A T I C A :
 O R,
 H Y D R O S T A T I C S
 A P P L I E D T O T H E
 M A T E R I A M E D I C A .

S H E W I N G

How, by the weight that divers Bodies used in Physic have in Water, one may discover, whether they be genuine or adulterate.

To which is subjoined,

A previous hydrostatical Way of estimating O R E S .

The P R E F A C E .

I Am far from being fond of their practice, that affect to give pompous and promising titles to their books; insomuch that my friends have several times reproached me with inclining too much to the opposite extreme. But yet I am not averse from prefixing to the ensuing paper the title of *Medicina Hydrostatica*; not only for the conveniency of citations, (which are usually troublesome to make in tracts that have long titles) but because too I am invited, if not authorised to do it, by the example of the famous and judicious Sanctorius, who scrupled not to prefix the name of *Medicina Statica* to a writing almost as small, as it is ingenious, which applies the balance to some uses relating to the medicinal art, perhaps not more than will be here found proposed of the same instrument, improved by some additions. And it is scarce to be doubted, but that, in this inquisitive age, the sagacity of the curious will make, both of what he has discovered, and of what I have delivered, useful applications, that neither he, nor I, ever thought of.

If the chief thing I aimed at in writing, had been to gain applause, I would have taken a more likely way to obtain it, than by treating of a subject, wherein few will think themselves concerned, (though many in reality be so) and whose importance does not at first view appear. And this subject too the nature of it has obliged me to treat of in such a way, that it will be almost as unpleasant to the reader to peruse so unadorned a piece, as it was troublesome to the author to write so toilsome an one. And indeed, when I came to take notice of the number of particulars, that I had brought together into this little book, I did myself somewhat wonder, how I came to be prevailed with to lay out so much pains upon so uninviting a subject. But knowledge and health are two such valuable things, that I durst not refuse to undergo even a toilsome task, whilst I was encouraged by the hope, that was given me, that this kind of labour may conduce somewhat to those desirable ends; if not otherways,

yet at least by exciting the more curious among physicians, chemists, and others, to enlarge their inquiries; and by helping them to remark divers things relating to medicinal bodies, that they are wont to overlook.

I HAD probably better consulted my reputation, as well as my ease, if, having contented myself with those few uncommon notions, that the rest of the book was built upon, I had left the application made of them to particular bodies, to the industry of others. I shall not solicitously excuse myself, for not having bestowed more ornaments upon the following essay; since the nature of the subject, and drift of the writer, are sufficient to justify the plainness of my stile to the judicious. I may have somewhat more cause to apologize for this, that I have not cast a treatise, about a subject wherein mechanics are so much employed, into the form of propositions, and given it a more mathematical dress. But I was unwilling by that means to discourage those many, who, when they meet with a book, or writing, wherein the titles of theorem, problem, and other terms of art, are conspicuously placed, use to be frightened at them; and, thinking them to be written only for mathematical readers, despair of understanding it; and therefore lay it aside, as not meant for the use of such as they.

BUT there is another thing, upon whose score, I confess, I ought to wish for indulgent readers. For the papers compiled into this essay having been written in loose sheets, and at such distinct times, that divers accidents intervened between them; the loss of some of those papers, as well as others of different natures, and my want of health and leisure, obliged me to change more than once my proposed design, and to employ sometimes the stile of a private letter, and sometimes again that of a discourse intended for the public; by which means some things, and some expressions, that were suitable to the design I had, when I committed them to paper, became incongruous, when the scope and scheme of my discourse were altered; especially some parts of the copy being out of my hands, when I should have adjusted the others to them. But though these irregularities may keep the parts of this essay from being so coherent as they should be, yet they will not prove very prejudicial to an intelligent reader, who, finding the matters of fact, and the notions to be true, may, notwithstanding the want of an uniform contexture, make good use of them.

THOUGH divers little memoirs and other things, that occurred to me from time to time, whilst I was bringing together the following papers, have insensibly swelled them into a book; yet the essay itself was, in my first intention, but a large fragment of a greater work: whereof an account is given in the letter to a friend, (that is premised to a paper annexed to the following essay) which (letter) having been intended for a kind of preface to the last scheme of the whole larger scheme, if the reader please to peruse it, he will there find the rise and scope of this little tract, as well as of the other parts of that designed book; and some other things, that may make it needless to lengthen this preamble by any thing more than two advertisements. Of these, one is, that (being reduced, by divers unexpected and unwelcome accidents, to forego my first design, and give only two or three specimens of what was intended, and more than begun) I made choice of the title of the chemical changes of bodies by coloration, as a sample of the chemical part of the treatise; and I pitched upon the subject of this present essay, as a specimen of the mechanical part of the same treatise: the other advertisement is, that the reader may not be startled, to find some little variations of specific gravity among some of the memoirs laid together in this essay, because he will in due place be told, why such things ought to be expected. And in the mean time, it may, I hope, suffice to say, that such variations are neither new, nor easily avoidable things, in making hydrostatical experiments,

or

or others of affinity to them. For proof of which, to readers that, for want of having made trials themselves, may distrust what we have said, I shall produce a couple of notable testimonies. The first is given by so industrious and diligent a mathematician as *Mersennus* * himself. For he candidly acknowledges, when he has occasion to mention some trials of the learned *Ghetaldus*, and of the accurate French engineer monsieur *Petit*, and of his own, that the variety of weighing, which often happens to amount to some grains, is but like the variety of astronomical observations, which do almost always differ in some minutes or seconds. To which he soon after adds an intimation, that shews, that he expected not an exact uniformity between the observations of *Ghetaldus*, &c. already made, and the trials of an experimenter, that would examine them by making the like again.

To this first testimony we shall subjoin the second; which is, that our famous experimenter, the lord *Verulam* himself, writing of a subject, that in several things has much affinity to ours, confesses, that it is not to be doubted, but that many of the bodies, which † he has set down in his table of their dimensions and weights, differ in the same species or denomination, some being heavier than others; and that therefore there is some contingency in this affair, so that it is not necessary, that the individuals he made his trials with should be exact standards of the nature of their respective species, or should (which makes directly to my present purpose) agree altogether to a tittle with experiments of other men.

BUT this scarce evitable imperfection of hydrostatical and the like experiments does not hinder, but that by their help we may make good estimates of the weights, and bulks, of very many bodies; and among them of not a few, that belong to two sorts of the three, that our illustrious author acknowledges to be reducible to his way of mensuration. And these estimates will (if I mistake not) be found, not only preferable to those, that can be of the same bodies by geometrical instruments, but (which is more considerable for the reader) accurate enough to be very useful on a great number and variety of occasions. Which last clause I purposely add to insinuate, that the hydrostatical way of mensuration may be usefully applied to several bodies and cases, that do not at all seem to relate to the *Materia Medica*; as would appear by inserting here what is delivered about metrical and about exploratory observations in other papers; if that were not too foreign to the ensuing essay, as not belonging to the subject, or to the design of it.

M E D I C I N A H Y D R O S T A T I C A :

A N

E S S A Y.

C H A P. I.

I HAVE, in a former tract, endeavoured (and, as I am told in print and otherwise, not altogether unsuccessfully) to make it probable, that divers (if not most) of the real virtues (for many fabulous ones have been ascribed to them) of gems or

* *Varietas ponderandi, quæ sæpius in quibusdam granis contingit, similis est varietati astronomicarum observationum, quæ semper ferè quibusdam minutis, sive primis, sive secundis differunt.* Mersennus in *Phænomenis Hydraulicis*.

† *Hist. densit. & rarit. P. M. 12. Editionis Londinen. in Octavo.*

precious

precious stones may in great part proceed from the qualities of metalline and mineral substances, that, whilst the matter was either fluid or soft, were (more or less plentifully) incorporated with the stony matter, which hardened afterwards into a gem. The same phænomena and reflections, that led me to the opinion newly recited, induced me to think it also very probable, that divers boles, clays, and other earths, and much more that several minerals, which, though not looked upon as metalline ores, and several stones or stony substances, that, by reason of their bigness or opacity, or perhaps unpleasant colours, have been judged unworthy to be numbered among gems or precious stones, may yet be endowed with considerable medical virtues; and perhaps with greater than the finer gems themselves, because in these despised stones and minerals there is often found a greater store of metallic and mineral parts, which, while they were in *solutis principiis*, as chemists speak, might with ease plentifully insinuate themselves into these more open bodies, where being settled, they were not locked up so fast and strongly, as in the nobler gems; such as diamonds, rubies, sapphires, &c. which are of so compact (and as it were glass-like) a nature, that divers corrosive liquors, and aqua fortis itself, are unable to penetrate and dissolve them; though, as hereafter will appear, these inferior medical stones, and other minerals, may be opened by the like menstruums.

UPON these grounds, I thought it might be a thing of use to physicians, as well as to divers mineralists and mine-workers, if I imparted to them a way of exploring many fossils, that I do not remember I had met with, either among physicians or chemists: and though this way of exploration pretends not to discover directly more than one quality of the body examined by it; yet that quality, being its specific gravity, is so radical and considerable a one, that it may lead a sagacious enquirer further than at first sight one would think.

I CONSIDERED then, that the most pure and homogeneous kind of stones that we know of, and that seems the freest from all adventitious mixtures, and even * TR's, is rock-crystal: and therefore I pitched upon this, as the standard I would employ, to make estimates of the greater or lesser recess from simplicity or homogeneity of the stones, or other stone-like substances, whose specific gravity I should examine.

WE took then some pieces of native crystal, clear and colourless; and having carefully weighed them, first in the air, and then in water, we found, by computation, that pure crystal was to clear water of the same bulk as two and an half, or thereabouts, are to one: so that, to clear the matter by an instance, if we suppose an hollow cube, of brass or other metal, to be filled as carefully as may be (for the upper surface will scarce be exactly level) with $\frac{3}{4}$ of water, and if afterwards the cavity of the emptied vessel be exactly filled with a cubical piece of rock-crystal, this stone will weigh $\frac{3}{4}$ and about an half. Some of my trials, indeed, made with tender balances, represented the proportion of these two bodies with some petty variation. But besides, that it is not improbable, that differing pieces of rock-crystal itself, though of equal bulk, may not be precisely equal in ponderosity; besides this, I say, the variation I found from the newly assigned proportion was so small, that having just intimated, that for the most part it rather favoured a little the specific gravity of the crystal, than fell short of it; we may neglect it without any prejudice, worth taking notice of, to the use that is to be made of this proportion in this paper. And forasmuch as there may be some scruple, though groundless, made about the origin and nature of crystal; I shall add, by way of confirmation of what has been delivered, that I procured some strong icicles, that had been fastened to vaults, &c. as bodies that would be acknowledged to be true stones, and yet to have been in a liquid form; and having hydrostatically examined these concretions, the specific gravity, though

* Tinctures.



though not exactly the same in all, appeared to be little differing from that of crystal; the solid body exceeding the weight of the fluid water, it was weighed in, about two times and an half (a little more or less.)

To apply this fundamental observation to uses designed in it; when I had a mind to make a probable discovery (for by this way I pretend to no more) whether in a stone, or stone-like body propounded, the merely stony matter were more or less commixed with some adventitious substance of a metalline nature, or that of some other mineral more ponderous than crystal, I carefully weighed it, first in the air, and then in the water, according to the method formerly declared; and if by virtue of its specifick gravity, its proportion to water of the same bulk exceeded the proportion of five to two (which, to avoid fractions, may be commodiously substituted to that often already mentioned of $2\frac{1}{2}$ to one) I concluded it probable, that the concretion had in it a portion of adventitious matter, heavier in specie than crystal or mere stone: by how much more or less the solid body exceeded the weight of water equal to it in bulk, by so much greater or lesser a portion of heterogeneous matter was guessed to be commixed with the stony in the propounded concrete. This may be illustrated, as well as proved, by the examples, that should presently follow, but that it will be fit, before I descend to particulars, to premise a paper, that concerns the whole design of this tract.

C H A P. II.

THOUGH the way of weighing solids in water hath been delivered by the ingenious *Marinus Ghetaldus*, and, out of him, by some few other authors; and though therefore I might excusably dispense myself from delivering it distinctly; yet since their books are scarce, and the knowledge of this way is almost every where supposed in these papers, I hold it very fit, that it should once be proposed in this tract, not only for that reason, but for two others. One, that a dexterous way of finding out the weight of bodies in liquors may be of far more use than men seem to be yet aware of, being capable of being made, by a little variation and improvement, of good use to naturalists, and even to chymists. And the other, that perhaps you will find cause to think, that experience and reflections on it may have furnished me with some few expedients and cautions for the better practice of this art, and for the avoiding of some errors, that may be very easily, and perhaps have been, run into, for want of the cautions here given.

The way of weighing sinking bodies in water.

THE solid body, given to be examined, is to be tied about with an horse-hair of a competent length, which hair at its other end is to be fastened to one of the scales of a tender and exactly equilibrated balance; so that the proposed body being exactly weighed in the air, and then immersed in a glass or other fit vessel, almost full of fair water, may hang freely in that liquor, being on every side encompassed by it. This done, you must put into the opposite scale as many weights as serve to bring the body hanging in the water to an exact æquilibrium with the counterpoise, and consequently the beam of the balance to an horizontal situation. Then take out the weights newly employed, which give you the weight of the body in the water, and deducting it from the weight formerly taken of the same body in the air, and by the remainder, which will be the difference of these two, divide the whole weight of the given body in the air, and the quotient (whether consisting of

Hydrosta-
tical para-
doxes.

whole numbers, or a fraction, or both) will shew the proportion, in specific gravity, between the examined solid, and as much water as is just equal to it in bulk. To make this more easily intelligible by an example; we took a fine piece of white marble (that stone seeming the most pure, and most free from mineral tinctures of any common opacous stones:) this being put into a good balance, whose scales were well equilibrated, was found to weigh in the air, $\text{z}ii. \text{z}iii. \text{vi}$, grains ix. which, for conveniency of supputation, we reduce to 1169 grains; then an horse-hair was tied about this piece of marble, and the other end of the same hair was fastened to one of the scales, under which, at a convenient distance, was placed a somewhat deep glass, almost full of fair water: in this liquor the stone was made to hang freely beneath the surface, and in the opposite scale there were put weights enough to bring it to an æquilibrium with the other; these weights were found, being reduced to the former denomination, to amount to 738 grains, which gave us the weight of the marble in water (which was much less weight than the former, because the stone was partly sustained by the water:) this being subtracted from the weight of the same stone in the air, there remained 431 grains, which gave us the weight of as much as was equal to the stone in bulk. By this remainder the weight of the marble in the air, viz. 1169, being divided, the quotient was found to be 2 and $\frac{7}{100}$, or near enough $\frac{7}{100}$ for the proportion in specific gravity of white marble to water. The demonstration of this practice is founded on what I have elsewhere given; and it may, in another way, be found in some of the commentators on *Archimedes de insidentibus humido*.

FOR understanding of the summary direction newly given, it may be useful to subjoin the following notes: 1. It is manifest by the nature of the thing, that the body, proposed to be weighed, ought to be heavy enough to sink in water, since otherwise its weight in that liquor being none at all, cannot be significantly deducted from its weight in the air. But if there be occasion to weigh in water a body lighter in specie than it, as bees-wax, a piece of fir-wood, &c. it may be done, though not without some trouble, by joining to it a body, heavy enough to make the wax sink with it: but this case belongs not to this place.

2. AN horse-hair is made choice of for hydrostatical operations, because it is said to be equiponderant to so much water; and though I have not found that to be strictly true, yet an horse-hair is fitter to be employed in these trials, than any other string I know of; and its specific weight usually differs so little from that of water, that the difference may be safely enough neglected; and if the solid proposed be too heavy to be sustained by a single horse-hair, one may twist two, or (if need be) more of them, to make the string strong enough to sustain the solid.

3. I SHALL add, that I have met with bodies, about which, by reason of their roundness, as in bullets, or of some other inconvenient figure, we could not well fasten an hair, or other string, wherewith to tie it to the balance. Now, on such occasions, I caused some hairs to be so contexed, as to make a kind of a little hoop-net, whose meshes were not great enough to let the body slip through them. In this small vessel, whether you call it a net or a basket, which was tied by an horse-hair (single or twisted) to one of the scales, we put the solid body to be weighed, and proceeded in the operation, as if the body were tied but with a string.

4. BUT here it must be carefully noted once for all, that whensoever any hydrostatical trial is made with an horse-hair, there must be put into the scale, that holds the counterpoise, as much of the same hair, as can be guessed to be of the same weight with that part of the string, that sustains the body in the water, which appears to be above the surface of the water; for this liquor takes off the weight only of as much.

much of the hair as is immersed in it, so that the unimmersed part of the string adds to the weight of the solid hanging in water, and therefore ought to be compensated by an equal weight put into the opposite scale.

5. WHEN I kept a balance only or chiefly for hydrostatical trials, I found it expedient, on divers occasions, to take off one of the scales, with the strings belonging to it, and substitute in its room a piece of lead, or other metal, of a conical, or some other convenient shape, exactly equiponderant to the opposite scale, and at the same end of the string to fasten one end of the horse-hair, that tied the body to be weighed in water. And sometimes also, when I did not take off one of the scales, I caused it to be perforated in the middle (yet without lessening its weight) that so the body to be immersed might hang very perpendicularly from the midst of the scale. The motives, that induced me to these practices, cannot be so well set down in few words; and therefore shall be now left unmentioned, especially because the practices themselves, though on some occasions convenient, are not necessary.

6. THERE remain yet a couple of remarks, which must less than any be pretermitted, if men would avoid some errors, that are but too often slipped into by the makers of hydrostatical trials. We are then (first) to take notice, that the body to be examined hang freely in the water, so that no part of it any where touch the bottom or the sides of the vessel, or reach above the upper surface of the water contained in it; for, if any of these circumstances be not taken care of (as it happens, when we are not heedful enough) the true weight of the solid is somewhat altered; and if any corner, or other part of the body (and the like may be said of the horse-hair it is tied with) though but a small one, appear above the surface of the water; that extant portion, being not at all sustained by the liquor, adds (more or less) to the weight, that the immersed body should have. Care also must be had, that as nothing but the water do touch the hanging body, so no part of the water may touch the scale whence it hangs. I have several times observed, that immersed bodies have been concluded to weigh more in the water than really they did; because, through such a want of heedfulness, as is not uncommon, the experimenters did not take notice, that if the string were too short, or the vessel too full, the vibrating motions of the balance would, at one time or other, carry down the scale the suspended body was tied to so low, as to make one part or other of it touch the surface of the water; some drops of which liquor would readily stick to it, and, because they adhered to the nether part of it, would lie concealed from an eye that was not prying, and by consequence would sensibly add to the weight of the scale, and make the body be thought heavier than indeed it was; which oversight must needs be very prejudicial, when one makes experiments, that require exactness.

7. BUT the most usual cause of mistakes in hydrostatical trials (especially such as are made on small bodies) wherein a little error may be greatly considerable, is this; that men are wont to think it sufficient (in these trials) that the body to be examined be totally immersed in the water; whereas it does not only often, but most commonly happen, that the given solid, and the string that is tied about it, carry down with them divers particles of air; and perhaps too it may find and extricate others, that lay concealed in the pores of the liquor itself; which aerial particles fasten themselves to the little asperities, that they meet with on the surface of the immersed bodies, in the form of bubbles, which, like so many little bladders full of air, endeavour to buoy up the body they adhere to; and on that account do, in proportion to their number and bigness, lessen the weight, which the immersed body would otherwise have in water. And therefore great care is to be had, especially in nice experiments, that, by shaking the string, and warily knocking the body against the sides

of the glass, the adhering bubbles may be displaced, and emerge to the top of the water. And I shall add a desire, that on some occasions this caution be made use of more than once in the same trials; because I have several times observed, that now and then after the immersed body was freed from the first bubbles, that appeared about it, others did succeed, before an end was made of weighing the body; out of some of whose unperceived cavities or pores (whether superficial or lying deeper) perhaps the latent air could not easily on a sudden be driven by the water. I have been the more circumstantial in explaining the summarily proposed method of weighing bodies in water, because experience hath shewn, that it is not near so easy as upon the first reading of it one would presume, to be exact in the practice of it.

HAVING obtained the weight of a body proposed, first in the air, and then in water, according to the method plainly delivered; it will not be difficult to discover practically the proportion in weight between the solid and the liquor. I say practically, because the rule is easy enough, though the demonstration is not so readily to be understood by them, that are not acquainted with the principles of the hydrostatics. The theorem, upon which our practice is grounded, was first, that we know of, delivered by the most sagacious *Archimedes*, whose commentators have busied themselves in demonstrating it in a mathematical way, as I have since endeavoured to do in a physical way, and more easy to naturalists in the hydrostatical paradoxes. *Archimedes's* proposition is this, *that a body heavier than water weighs less in water than in the air, by the weight of as much water as is equal to it in bulk or magnitude*: whence it is not difficult to deduce a rule sufficing for our present purpose. For if you subtract the weight of the body proposed, whilst it is every way environed with water, from the weight of the same body, which it was found to have in the air; the residual number or difference gives you the weight (taken in the air) of as much water, as is equal in magnitude to the solid proposed; so that having now two bodies, one firm, and the other liquid, together with the weight of each of them apart; to find their proportion you need but divide the greater by the lesser, and the quotient compared to one, that is, to an unit, will be the antecedent of the proportion desired between the solid body and the water, which is mentioned but as it is the liquor, that is generally employed in these experiments, for otherwise the rule will hold, *mutatis mutandis*, in other liquors, as well as in water.

C H A P. III.

AND now having premised these remarks, and thereby made way for the clearer understanding of the subsequent part of this paper, we shall proceed to the examples, that this not unnecessary digression has diverted us from propounding.

THERE is a deeply red and opacous mineral, that commonly passes in the shops under the name of lapis hæmatites, though it seems to have more affinity to that, which divers authors call schystos. But whatever be the most proper name that belongs to it, it is an hard fossil, which, though little used by our English physicians, is in several places abroad in great request; and that not without cause, as far as I can judge, by what I yet know of it; and especially for that somniferous quality, that may be observed in some of its preparations. But it is not here, though it is elsewhere, my purpose to deliver its medicinal virtues; but only to examine, whether, according to our method, it ought to be concluded to abound with metallick particles (perhaps but embrionated) to whose intermixture some of its virtues may probably be ascribed. Therefore, in a very good balance, having weighed a piece

piece of English hæmatites, that chanced to amount to about $\text{Ziii. ziii}^{\frac{1}{2}}$, first in the air, and then in water, we found its proportion to this liquor, as $4\frac{1}{100}$ to 1. At which ponderosity, if I had not formerly made the like experiments, I should have been surpris'd, as you probably will be, when you consider, that this metalline stone did not very much want of almost twice the weight of a mere stone of the same bulk. This great weight much confirm'd me in the conjecture I had made, that in this lump was contain'd a good deal of metalline substance. And this induc'd me (to add that upon the by) to examine my guess, by subliming it, when finely powdered, and diligently mixt with an equal or double weight of sal armoniac. For then having tast'd with the tip of my tongue, of this saffron-colour'd sublimate, I found it, as I expected, very astringent or styptick, as divers preparations of *Mars* are wont to be; and, for further proof, having put less than a grain of it into a spoonful or two of good infusion of galls, there was immediately produced a black, and as it were inky mixture.

LAPIS lazuli is sometimes made use of by European physicians, but more frequently by Arabian and other Eastern ones, for divers purposes, but especially to make evacuations by vomit. This emetic faculty seem'd likely enough to belong to it upon the score of a metalline ingredient; and accordingly, having examin'd hydrostatically a piece, that was judg'd moderately rich, we found the proportion of it to an equal bulk of water, to be as 3 to 1; which argues, that, notwithstanding its briskness in operation, it contain'd a much lesser proportion of metalline substance, than lapis hæmatites, or divers less operative minerals.

I ELSEWHERE shew, that the loadstone may be apply'd to medicinal uses; and that it emits effluvia, that are not magnetical, and may have sensible operations upon the body of man. On which account it was not improper to examine it hydrostatically; by which means I found, that the weight of a lump of loadstone, that I judg'd to be either English or Norwegian, was in proportion to water of the same magnitude, as $4\frac{9}{100}$ to 1. But of the specific gravities of loadstones much more may be met with in another paper.

Observation about the loadstone, as it is a mineral.

LAPIS calaminaris is often enough used in physick, especially by chymists, to dry, and to imbibe acidities; for which uses, I prefer it before divers more famous drugs. But, though it is wont to be employ'd only as an external remedy, yet some things, that I found in some uncommon chemical preparations of it, made me think, it may deserve to be further examin'd and try'd. A famous and not unlearn'd empiric, to whom I willingly communicat'd some processes, that he desired of me, when I ask'd him about a medicine, whose success brought him a great number of patients, for griping fluxes, and some dysenterical ones, candidly discover'd his medicine to me, and solemnly assur'd me, it was nothing but pure and well-ground lapis calaminaris, seasonably given in a just dose; as in a fitter place I have more fully declar'd. This made it obvious for me to conjecture, that lapis calaminaris participat'es of a metallic nature, as may be argu'd from its operation upon copper, which is thereby turn'd into brass. Wherefore weighing a piece of this fossil, first in air, and then in water, it appear'd to be to this liquor as $4\frac{6}{100}$ to 1.

If I had not among some other papers lost some, wherein I had registr'd a good number of trials of this kind made upon differing fossils, it would be easy for me to add to the four already recited, others manifestly conducing to the same purpose. But presuming, that those already deliver'd may at present suffice, I shall now subjoin a few observations, whereof the first may become the candor and impartiality of

of a lover of truth, and the rest intimate some further uses of the hydrostatical way of exploring hard and ponderous concretions, hitherto treated of.

I MUST not therefore forbear to admonish you, that, though when an hard fossil propounded, is found to be much heavier than crystal of the same bulk; it is a very probable token, that in the solid concretion, there is a notable portion, greater or lesser, of some metalline or other ponderous mineral body, whence its good or evil qualities, in reference to human bodies, may probably be deduced. Yet, this hinders not, but that it is very possible for a fossil to be endowed with medicinal virtues, or to have noxious qualities, on the account of a portion of extraneous matter; though its specific gravity doth but little exceed that of crystal, or the advantage seem but inconsiderable. For (to pass by other reflections) a very small proportion of adventitious, metalline, or mineral substance, if it be of an operative nature, may, in some cases, suffice to diffuse its self through the rest of the mass, and impregnate it with active qualities. Which may be partly illustrated, and partly proved, by some experiments, that will be hereafter met with in one of the chapters.

C H A P. IV.

USE II.

TO hint somewhat about the further utility of our hydrostatical way of enquiry, I shall take notice in the first place, that it may assist us to guess with probability, whether a mineral body propounded, as likely to be a stone, or of a stony nature, be so indeed. Thus coral, for instance, is by some thought to be a plant; by others, a lithodendron; but by the greater number it is reckoned among precious stones. In this dissent of opinions, the specific gravity may be of considerable use. Wherefore, we thought fit to weigh a piece of choice and well coloured red coral, first in the air, and then in the water, and found its proportion to the weight of as much of that liquor, to be as $2\frac{6}{100}$ to 1. So that its specific gravity much favours their opinion, who take it to be a stone, since it not only equals that of crystal, but somewhat exceeds it.

THERE are some, that will have pearls, because of their hardness, and their being treated of by jewellers, and others that write of gems, to be of a stony nature. Wherefore I thought fit to examine their ponderosity also. But not having now with me any trial of that kind, I shall substitute one that I made upon a monstrous pearl, that was presented me by a person, that took it out of the oyster. I call it monstrous, because though it be well enough coloured, yet its shape is irregular, and its bigness extraordinary, as is also its weight, amounting to full 206 grains. This being weighed in water its proportion in gravity to an equal bulk of the liquor was found to be as $2\frac{1}{100}$ to 1. So that its specific weight was much about the same with that of crystal.

THERE are many, that take the stones formed in mens bladders for as true and genuine stones, as those that nature forms in the greater world; and speak much, and sometimes not without ground, of the great hardness of divers of them. But, though I deny not, that, in a laxer sense, they may well enough pass for stones, yet I should rather call them animal stones, than simply stones; this name having been constantly and generally used to signify mineral or fossil stones: which by our way of exploration, may be easily distinguished from human calculi, and other like hard concretions, found in the bodies of some animals. For, having examined a good number of these stones, I found, that not only the chemical analyses I made

of them, of which I elsewhere give an account, manifested them, how hard soever they were, to be concretions belonging to the animal kingdom, not the mineral; but, by an hydrostatical examen of divers of them, I found them to differ much in specific gravity from true fossil stones. Of this you will, in its proper place, meet with several instances; so that it may here suffice to mention two, that now chance to come to hand; namely, that a calculus humanus weighing above 3viß was found to be in proportion to an equal bulk of water, as $1\frac{7}{10}$ to 1. And another that weighed 3iv and above an half in the air, being also weighed in water, appeared to be to this liquor, as $1\frac{6}{10}$ to 1.

I MENTION these stones as belonging to the *Materia Medica*, though they are looked upon rather as diseases, of which, indeed, they are very sad productions, because a famous and experienced physician, that practised long in the *East-Indies*, and had better opportunity than almost any European had before him to try the virtues of bezoar, does either equal or prefer the calculi we are speaking of even to oriental bezoar.

AND to shew, that men are not the only animals, wherein stone-like concretions differ in specific gravity, (and so may be distinguished by that difference) from crystal and such like true stones; we shall subjoin two or three experiments, made upon choice bezoar stones, not exceeding a middle size, such being the likeliest not to be adulterated. The first of these weighing in the air 3iij, and odd grains, was found to be in proportion to water of the same bulk, as $1\frac{4}{10}$ to 1. Another weighing somewhat less than 3iij, was to the weight of an equal bulk of water, as $1\frac{5}{10}$ to 1. I might add divers other instances of the like import; and though I think them not necessary, yet I shall subjoin one more, because it is afforded by a bezoar stone, taken out of another of the same kind: this kernel stone, if I may so call it, being weighed in the air, wanted nine grains of 3iij, and its proportion to water of the same magnitude, was found to be as that of $1\frac{5}{10}$ to 1. In all which instances we may observe, that these animal stones, not amounting to twice the weight of water, equal to them in bulk, have less of specific gravity by above a fifth part, than a true fossil stone (such as crystal) is wont to be endowed with.

C H A P. V.

THE use lately proposed of our hydrostatical way of exploration suggests to Use III. me another, which may be deduced from it as a kind of corollary.

THIS comprehends two somewhat differing ways of applying the observations we have lately mentioned. For first, we may by the hydrostatics be assisted to discover, with probability, the resemblance, or the difference, that may be between bodies of the same denomination, so that some subordinate species of them may perhaps be distinguished, as well as several individuals of the same, or lowermost species. Since, for instance, we have found a notable difference between the specific weights of several loadstones that were dug up in several countries or mines; if greater number and variety of experiments of this kind were made, we should possibly find that, *ceteris paribus*, the loadstones of one country, or of one mine, are considerably heavier than those of another; as, if I mistake not, I usually observed, the Norwegian and the English loadstones to be heavier in specie, than those that are said to come out of a warmer region, *Italy*; whose island of *Elba* abounds with mines, whereof I saw one entire mass, that I judged to weigh a great many hundred of pounds. And this difference of weight between fossils of the same kind, when it is considerable, may be of good use to help us to distinguish between the stones of the same

same lowest species, that are proper to differing countries or mines. But, in case the unequal weight proceeds, as it often does, from an adventitious matter, that insinuated itself into the more genuine matter of the fossil, whilst it was fluid or soft, it may much assist us to guess at the greater or lesser purity of the homogeneity of the fossil proposed; which discovery may, on divers occasions, be of no small use to the physician, the jeweller, or the naturalist.

C H A P. VI.

Uſe IV.

BUT the second thing comprised in our corollary may in divers cases be of much greater utility and importance, as being very proper to help us to discern genuine stones, whether animal or mineral, from counterfeit ones; which too often pass for true, to the great prejudice of physicians and patients, and the great loss of lapidaries, and their customers. For as there are few qualities appertaining to ponderable bodies here below, that are so radicated (if I may so speak) as their ponderosity is; so there is scarce any quality, wherein 'tis so difficult for impostors to make a notable alteration unperceivedly, as the specific gravity. I said, for impostors; because, though in several cases, it is not so very difficult, to alter the specific weight belonging to this, or that kind of bodies; yet in those very cases, it may be exceeding difficult, and perhaps impracticable, to make a considerable change in that quality, but by such additions, or operations, as will make a sensible change in some other qualities too, and thereby expose the fallacy to be discovered. And this will especially prove difficult in many cases to vulgar cheats, and counterfeits, or adulterators of gems, and other valuable minerals; because the little knowledge they have of the numerousness and variety of natural and artificial productions, confines them to a small number and diversity of means, to accomplish their fraudulent designs. And whilst they are intent but upon counterfeiting the more obvious qualities of things, and perhaps of eluding the known and vulgar trials men are wont to acquiesce in, they are not like to take care to maintain the specific gravity, and secure their adulterated wares, against an hydrostatical way of examen, which, probably, they never so much as heard of. By this means, several pearls for instance, may be discovered to be counterfeit, without in the least injuring them. And, I remember, that some fictitious corals, that, for divertisement, I made, to shew what might be done in that kind, were, notwithstanding their fine colour, shape, and glossiness, easily discoverable, by their having a specific weight manifestly exceeding that, which belongs to natural corals.

BEFORE I knew better ways, I have sometimes for recreation, by the help of minium, made pastes, or fictitious gems, which, though transparent, and finely enough coloured, yet, because they contained some vitrified lead, added to the other ingredients, to promote the fusion, were liable to be detected by an easy hydrostatical trial of their ponderosity. I have likewise seen a fair bezoar-stone, that so resembled a genuine stone, that a great price was set upon it. But being brought me to be judged of, I made little doubt of its being counterfeit, by reason of its appearing to me as heavy as a mineral stone of that bulk; though the possessor being loth to expose it to an uncommon trial, I could not so cogently evince, that I had a clear reason to disadvise the purchase of it.

C H A P. VII.

Uſe V.

AFTER these instances, (which are not the only, that might be alledged of this kind) the affinity of the subjects invites me to take notice of another use,

or, at least, a variation of the former, which may be made of our hydrostatical way of examining solids. For it may, on divers occasions, assist us to make probable estimates of the genuineness (or the degree of purity) of several bodies, that are, or may, usefully be employed in physic, though they be not stones or minerals, provided they be heavy enough to sink in water. For when we have once found the specific gravity of a concretion of this sort, that we know to be genuine, and well conditioned in its kind; this degree of ponderousness may serve us for a kind of standard, whereby to judge of others of the same denomination, or that are said to be of a like nature.

To illustrate a remark, that has no more of difficulty in it than this, fewer instances will suffice (if any be necessary) than you will meet with in the following part of this tract, wherein they will opportunely occur. And therefore, instead of setting them down in this place, I chuse to give you an advertisement, that would surprise you, if I had not formerly hinted somewhat applicable to the same purpose, by no great variation. For that which I am about to serve you, is, that I think there should be made a great difference between the estimate, that men make of some stones, to which the shops give the name of gems, according as the estimate is to be made by jewelers and goldsmiths, or by physicians and chemists. For the tradesmen, who usually aim but at the beauty and lustre of the gems they would sell, may justly esteem those, *ceteris paribus*, the best, that are in specie the lightest, because such are generally more uniform as to sense, and more transparent; and also receive their colour from pigments of finer parts. But, on the contrary, those, that in gems seek mainly, if not only, for the medicinal virtues, may justly value those most, that are most ponderous; as having more plentiful portions of the metallic or mineral substances, whence the greatest part of their virtues is, as has been formerly noted, in probability to be derived. And this difference in specific weight, in stones that have the same name given them, I sometimes found to be far greater than one, that has not tried it, would imagine; as may appear by some instances applicable to this argument, that will hereafter be met with. But yet, I would not hence infer, that even such stones, whether transparent or not, as appear fine, and are but light in their kind, must be devoid of particles, whether metalline, or of kin to them, whence they may be endowed with considerable medicinal virtues. For there are mineral pigments of so subtil a nature, that so small a quantity as will scarce make them sensibly heavier than gems that are less (or perhaps not at all) coloured, may be diffused through the whole matter, and at least impregnate every sensible part of it. This I shall illustrate by the following experiment, devised for that purpose.

FIVE grains of powdered zaphora, being mixed with ʒj. ʒss. of finely powdered Venice glass, and kept a full hour in fusion in a furnace, that gives an exceeding violent fire, afforded a transparent mass, that was throughout of a fine blue colour, and that deep enough; so that one part of the pigment sufficed to tinge by fusion above an hundred parts of the glass: and when for curiosity we made the proportion of the zaphora a little greater, taking eight grains of the pigment to ʒj. of glass, that is, one to sixty; the mixture having been kept for the like time in strong fusion, the mass was so deeply coloured, that the proportion of the tinging stuff to the rest of the water appeared too great to make a handsome gem.

AND further to manifest, that a quantity of metalline matter, though it be but very small, may suffice to give a tincture (and so to impart a virtue) to a glassy body, and even to gems; I shall add an experiment, that perhaps you will think somewhat strange. I had long conjectured, that there was in granates, especially in some that were deeply coloured, pretty store of metalline corpuscles of a martial nature; and

that those corpuscles are more than sufficient for the granate itself, into whose composition they enter, though not visibly, because of their extreme minuteness. Upon this supposition, I took a Bohemian, or rather German, granate, (for I never saw any Bohemian so large) that I had kept by me for a rarity, because of its bigness and deep colour, though it was not a fine stone to look on, notwithstanding its being transparent in those edges that were thin. This being reduced to very fine powder, (but not in an iron mortar, lest it should take something from the metal) we exactly mixed eight grains with an ounce of finely pulverised crystalline glass; afterwards the mixture was kept two hours in a furnace, that gives a stronger fire than ordinary wind-furnaces, by which means we obtained, as I expected, a pretty uniform mass, tinged of a sufficiently green colour, such as prepared iron or steel gives to pure glass.

C H A P. VIII.

WHAT has been hitherto delivered, may serve to shew, in some measure, the uses of our hydrostatical way of examining drugs, upon a supposition, that they are solid, and neither very minute, nor too light to sink in water. But I must not forbear to confess, and even give notice, that there are many simples, and other ponderable substances, that may, upon good grounds, be said to belong to the *Materia Medica*; which yet want one, or more, of the newly expressed conditions. Wherefore I must not conceal, that there are three things, which, though not necessary to the understanding of the usefulness of the foregoing part of this discourse, may, if they can be performed, much conduce to facilitate (for I dare not say to compleat) the hydrostatical way of examining bodies heavier in specie than water. And therefore, though I confess it no easy task to surmount the difficulties to be met with in this attempt, yet I shall endeavour to lessen them as much as I can, by offering to you the expedients, that I was wont formerly to make use of in the three cases I am about to mention: namely, first, when the body to be examined was liquid, and consequently could not be immediately taken hold of by an horse-hair, or any other slender string. Secondly, when the body proposed was either in the form of powder, or consisted of fragments, that were so small, that it was not possible, or at least not fit, to fasten each of them to an hair, and suspend it after the manner of a body of a greater bulk. And thirdly, when the solid, to be hydrostatically examined, though great enough in bulk to be tied about, was dissoluble in water, and consequently unfit to be weighed in that medium; since therein its gravity must continually decrease, whilst the operation was performing.

As to the first of the three difficulties lately mentioned, I suppose I need not solicitously premise, that the liquid substance, to be hydrostatically examined, ought to be heavier in specie than the water (or other fluid) it is to be weighed in, and of such a nature, as not to be apt (at least speedily) to mingle itself with it; since otherwise the proposed liquor will either emerge in that it should be weighed in, or else be confounded with it, and so retain no distinct mass or gravity.

SUPPOSING then, that the liquor, to be examined, has belonging to it the two newly recited conditions, we made use of this expedient to explore its specific weight. We took a small jar, or wide-mouthed glass, capable of containing an ounce or two of common-water, and weighing, in the air, about three or four drams (more or less, as occasion requires.) This glass, which, for brevity's sake, we are wont to call hydrostatical, or else glass-bucket, we weigh very carefully once for all, first in the air, and then in the water, and by the difference of the weights we find, according

to the known hydrostatical method, a weight equivalent to that of the substance of the glass in water; so that such a weight being put into the opposite scale of the balance, the vessel hanging under the surface of the water may be considered as having no weight at all, that is, no preponderancy. And consequently, the weight of a body contained in this bucket may be looked upon as that of the body itself in water, without being increased by that of the vessel; so that, in our instance, the bucket makes a mass of quicksilver, though fluid, as ponderable as if it were coagulated into a solid body.

THE glass-bucket being thus provided once for all, we put the proposed mercury into it, and weigh them together in the air; whence deducting the already known weight of the vessel itself in the air, the residue gives the weight of the quicksilver alone in the air. This done, by the help of an horse-hair we tie the bucket to one of the scales, (or to either end of the beam) and letting it, with the quicksilver in it, slowly sink into a glass, or other vessel, competently full of fair water, and hang so, that the bucket may not any where touch, either the bottom, or the sides of the larger vessel; we reduce, by weights put into the opposite scale, and added to the formerly mentioned counterpoise of the bucket in the water, the balance to an exact equilibrium, without raising the bucket quite to the surface of the water: this newly obtained weight of the immersed quicksilver being deducted from its weight in the air, it is easy, by the known hydrostatical method, to obtain the proportion in gravity between the given mercury and an equal bulk of water.

To expedite this operation, it may be convenient to have in readiness (as I was wont to do) a couple of weights of lead or tin; the greater exactly equal to the weight of the glass-bucket in the air, and the other equal to the weight of the same bucket in water. For, by keeping these two weights constantly in readiness, one has at hand a counterpoise of the vessel, in which soever of the two mediums it is employed in, which saves them, that have frequent occasion to use the balance, much of the time, that must otherwise be spent to adjust it.

THIS advertisement being premised, the lately propounded operation will be best understood by an example. We took a small glass jar, capable of holding about $\frac{3}{8}$ of water, and put it into one scale of a tender balance, whose other scale we furnished with a counterpoise, or weight equal to the glass. Into this little vessel we then put $\frac{3}{4}$, that is, four hundred and eighty grains of mercury, (affirmed to be Spanish, which is counted the richest) and the glass, with this mercury in it, was, by an horse-hair, made to hang from one end of the scales into a deep glass vessel of water. Whilst it was in that state, there was in the opposite scale a counterpoise to the glass itself in the water, so that the drachms and grains, that it was requisite to add, gave us the weight of the quicksilver only, the weight of the glass being already accounted for. But care was first taken, that the open-mouthed vessel should be every where environed with water, and diligently freed from adherent bubbles; and that a piece of horse-hair should be added to the counterpoise, to compensate that part of the string or hair tied about the bucket that was in the air, intercepted between the scale it was fastened to and the surface of the water. By this means we found the weight of the quicksilver in that liquor to amount to 446 grains, which being subtracted from the weight of the quicksilver in the air, the difference was 34 grains, by which the greater number being divided, the quotient was 14 and about $\frac{1}{16}$. So that the mercury, employed in this operation, appeared to be in gravity to water of the same bulk, as $14\frac{1}{16}$ to 1. I said the mercury employed in this operation, because in former trials I scarce found common quicksilver, that was bought in shops, to weigh full fourteen times, and sometimes scarce thirteen and a half, as much as a bulk of

water equal to it. Whether the ponderousness of our last used mercury proceeded from hence, that as some chemists extol Spanish mercury, as participating more than others of a golden nature, which opinion, a trial, that I purposely made of that employed about the late experiment, did not disavour;) so there was in this of ours somewhat of unfixed gold, that somewhat increased its weight, I leave to further inquiry.

If you can command, as I cannot, the learned *Ghetaldus's Archimedes promotus*, since, as I am informed, he there sets down the intensive weight of quicksilver hydrostatically found, it may be worth your while to consult that scarce book, and compare the things you may meet with there, relating to quick-silver, with what I have now delivered. To which I shall add, that this I may here give you notice of in general; that having, on chemical and other accounts, had more occasion than most men, to make trials of this sort, I did not find all running mercuries, though they did not appear adulterated, to be precisely of the same weight: nay, even distilled mercuries, if once combined with metalline bodies, and particularly, if they were animated, and drawn from fine gold, I found to differ more from common mercuries sold in shops, than these did from one another; and even between common mercuries, notwithstanding their having been distilled, we found a notable disparity. But to enlarge on this subject were improper in this place, where I mentioned the weight of mercury; but to give so clear (though but single) an instance of the way of measuring the weight of ponderous liquid bodies in water, as may warrant me to say, that, by this method, though not always with the same ease, we may explore the specific weight of other liquors, that are in equal bulk heavier than water, and yet are indisposed to mingle with it; such as are the chemical oils of cinnamon, cloves, guaiacum, &c. But the chief thing, that has made me the more circumstantial in delivering the foregoing experiment, was, that this practical direction, for weighing one liquor in another, will hereafter appear to be applicable to useful purposes; especially when we come to mention, in the following chapters, several cases, wherein liquors of a nature very different from water, may be substituted in its stead.

C H A P. IX.

AS for the way of examining hydrostatically the powders of sinking bodies, such as minium, putty, &c. or such small solids, or fragments of greater ones, as by reason of their littleness or inconvenient shape, are singly unfit to be tied with an horse-hair to the balance, as the fragments of rubies, and other precious stones, wont to be sold by weight at the drugsters or apothecaries shops; the way of discovering the weight of these in water differs not much from that lately delivered of weighing quicksilver in that liquor. For, on these occasions also, we employ such a glass bucket, as was lately described; and having made it very dry, as well within, as without, we put into it the metalline calx, or other heavy powder, or a convenient quantity of the fragments of gems, or a competent number of small (though entire) bodies, as pieces of native cinnabar, seed-pearl, &c. and proceed with these as we did with quick-silver. Only this caution is to be heedfully taken along, that we warily, and little by little, put into the bucket, whilst it is yet kept in the air, and hath the already weighed powder, or fragments in it, a convenient quantity of the same water it is to be weighed in; that the liquor may have time to insinuate itself between the dry bodies, and even the corpuscles of the powders, and expel thence the air, that was harboured in the intervals betwixt them; which little aerial portions, if not thus seasonably expelled, would, upon the immersion of the vessel,

vessel, produce in the water store of bubbles, that would buoy up, or fasten themselves to the fragments, or other small bodies, and make the experiment uncertain, or fallacious. And if it be a powder, that is to be weighed, unless it be beforehand thoroughly wetted, and thereby freed from aerial particles, and reduced to a kind of mud, there is danger, that some dry corpuscles of the powder will, when the vessel is under water, be buoyed up, and get out of it, and, floating on the surface of the incumbent water, take off from the true weight, that the immersed powder should have in that liquor.

If this way of examining bodies be carefully employed by a dexterous man, furnished with a tender balance, it may be of considerable use, not only to physicians, druggists, and apothecaries, that are conversant with the more precious kinds of sinking bodies, that belong to the *Materia Medica*, but also to lapidaries, and goldsmiths, whom it much concerns not to be imposed upon by counterfeit gems, or by other stones of price, that are not duly conditioned, in their kind. Thus the fragments of the five precious stones, that (upon what grounds I now enquire not) are made ingredients of some noble compositions, as *confectio hyacinthi*, &c. these fragments, I say, may each sort of them apart be usefully examined by their weight in water, by him, that knows the true specific gravity of a parcel of the finest, or else of such as he judges to be fittest for his purpose. And, to add that upon the by, whereas granates are reckoned among the five medicinal precious stones, and in some pharmacopœas are preferred to the first place, as the best; I have found so great a difference, in point of ponderosity, between European granates and American ones, whereof some were sent me as a present from *New England*, and others I myself picked plentifully enough out of an odd American mineral, which I suspected to contain them, that it was very obvious to think their virtues might be very different, if not as to kind, yet, at least, as to degrees. And not only such factitious pearls as have deluded many, and sometimes even famous jewellers, (as one of themselves, that was lapidary to a great monarch, confessed to me) may oftentimes by this expedient be discovered, especially if mercury (though disguised) be employed in making them; but we may probably by the same method discriminate the natural pearls of several countries and sorts, whereof I have seen a far greater difference than one would expect; and I have somewhere yet by me natural pearls of such various colours, as well as shapes, as have somewhat surprised even the curious. But because it more concerns physicians and patients, to be able to make estimates of seed-pearl, that are on many occasions of good use to health, than to know the genuineness of those bigger ones, that are seldom made use of, but for ornament; I shall here mention the result of an experiment, which I find among my old notes to have been made by me, when I was furnished with very fine oriental seed pearls. For having examined these, by the way we are now discoursing of, as judging them orient enough to be fit to be patterns, wherewith to compare others, we found these to water of the same bulk, $2\frac{75}{100}$ (i. e. $\frac{3}{4}$) to 1.

BUT in this, and in those other trials, whose difficulty, or importance, require, that we make them as exactly as we are able, I must advertise you, that it is not fit to trust to the steadiness of your hand in holding the balance, but that you make use of a gibbet as they call it, or some other stable prop to support it. For the hand often shakes, and makes the instrument, that it holds, to do so, and oftner grows weary before the scales have had time to play up and down, and at length settle in a determinate situation; wherein if you miss of a true æquilibrium, the hand must undergo a new penance: whereas, when the balance hangs on a stable fulcrum, you have both your hands to help you, and need not be tempted by weariness to desist, before

before the balance be brought to rest in a perfect æquilibrium. The neglect or omission of this practice I take to be one main reason (for the want of good balances, or of skill to use them, is oftentimes another) why so many of the experiments, that require weighing, are erroneous; as they that cautiously examine them (as I have sometimes had occasion to do) may easily find. And therefore (to add that, upon the by) I hope you will not make haste to censure the accounts I give of hydrostatical trials, because they do not always agree with those of other men; since perhaps they did not employ either more diligence, or better instruments, than I.

C H A P. X.

THE last of the three cases, formerly mentioned, namely, ‘What is to be done, ‘when the body to be hydrostatically examined will dissolve in water, or easily ‘mingle with it?’ imports a question difficult and troublesome enough to be resolved. Nor can this examen be performed by a single operation, which yet sufficed in each of the two foregoing cases. And having seriously considered the matter, the best expedient I could then think of was that, which divers years ago I propounded in an assembly of the Royal Society, and grounded on this reflection, that though the body proposed could not be immediately weighed in water, yet we may substitute another liquor, that will not dissolve it, and thereby investigate the specific gravity, in reference to that medium; and then, by comparing the difference of those two liquors in point of gravity, one may come to discover, what the body proposed would have weighed in water, in case it could have been kept there a competent time, without having any part of it dissolved. Considering then, that, except quick-silver, the visible fluids we can command, are either of an aqueous or of an oily nature; and that most bodies, whereof we can make solutions in liquors of the former, will not (at least sensibly) suffer themselves to be dissolved by those of the latter kind, whilst a proposed solid is weighing in them; we presumed, that the most saline bodies, such as alum, vitriol, sal gem, to which may be added borax, sublimate, &c. might be commodiously weighed in oleous liquors. Among these I made choice of oil of turpentine, rather than olive-oil, or any chemical essential oil; partly, because, being of common use, it is to be procured in sufficient quantity, and, being very cheap, is seldom adulterated, as chemical oils are too often found to be; and, partly, because, being a distilled body, it may be presumed to be free from aqueous parts, of which experience has shewn me, that common expressed oil is far from being destitute. But because two liquors, that are indeed both of them oils, are wont to have distinct names given them in the shops, I shall here intimate, that I do not, when I have my choice, make use of that which many call the oil of turpentine, but of that which first comes over, which those, that distinguish them, call the spirit of turpentine: I prefer this (I say) because it is clear, almost like fair water; whereas, that which is called the oil, besides that it is less fluid, is commonly of a yellow colour, which does lessen its transparency, and may be compounded with some of the coloured bodies to be weighed in it.

THERE are many persons, that would find it very difficult, and to whom, on most occasions, it will not be necessary, to know the determinate proportion in gravity between oil of turpentine, and the solid that is weighed in it; and to discover, by the help of that gravity, what the body proposed would weigh in water, in case it could be kept for a competent time in that medium, without having any part of it dissolved therein. And therefore, though, if you desire it, I shall, God permitting, annex the method of performing this task (which, you know, requires more calculation,

lation, than every common reader is able to go through with) to the end of this tract; yet, for the present it may perhaps be sufficient, as well as fit, that I give you notice, that those, that have not skill enough to determine, by the hydrostatics, the proportion between sinking solids, and the liquor they are weighed in, may yet be assisted, by what we have delivered about oil of turpentine, to make a not unuseful estimate, what is the specific gravity of divers bodies, in reference to others of the same (or a differing) species; and by that means, to make a probable guess, whether or no it be rightly conditioned; if he be but provided with one piece of the body, which he knows to be genuine or well qualified. For this may serve him as a standard, whereby to examine other bodies of the same denomination, that he may have occasion to purchase, or to sell, or to employ. As, suppose a tradesman be to buy a parcel of sublimate, he may take an ounce, for instance, or half an ounce of some of that he knows to be good, or rightly made; then having carefully weighed it in oil of turpentine, and set down how much it weighs therein; if he takes an ounce, or half an ounce, of the sublimate he would make trial of, he may weigh that, as he did the other, in the same liquor, wherein if it give the same weight with the standard, it is a good sign; but if it weighs not so much, it is a sign, that it has not its full or due proportion of mercury, and too great a proportion of salts, whence its comparative lightness proceeds. The same way of trying may be made use of for the examen of *mercurius dulcis*, and divers other bodies, totally or partly dissoluble in water, as of alum, which is often sophisticated with some baser salt, and of Roman vitriol, which is sometimes either counterfeited, or adulterated by the help of roch alum, and a tincture of copper. And according as the weight in oil of the body proposed recedes more or less from the weight of the standard, so the adulteration may be probably concluded to be lesser or greater.

C H A P. XI.

BEFORE I go off from this subject, it is fit, that I give you notice, that the hydrostatics may supply us with another way of estimating the intensive gravity of bodies, solid or fluid, that may on some occasions be of good use. The way I mean is this: we take a solid body, more than heavy enough to sink in water, and carefully observe, once for all, its weight in the air; then we weigh the self-same solid, first in one of the liquors we would examine, and then in another; and so onwards, if there be more than two: and having noted the difference between the solid, and each of the liquors, it is easy to find, according to the practice elsewhere delivered, the specific weight of each, and the proportions betwixt them. And in regard it is but one and the same solid, that is compared to the differing liquors; whatsoever their number be, it will not be difficult to compare the specific gravities of those liquors betwixt themselves, and to discover, by the weight of the first, that of any of the others, that one pleases.

THE proposed way having been but summarily delivered, it will not be amiss to subjoin some remarks relating to it.

AND first, if you intend to employ but one solid in your examen of liquors, it will be necessary you make choice of such an one, as hath a much greater specific gravity, than is necessary to make it sink in water. For there are some liquors, that are far, perhaps twice, more ponderous than this newly named. Secondly, the body ought to be heavy enough to sink in all liquors but quicksilver (for in that none but gold is ponderous enough to sink.) But if your trials are to be made upon liquors, that belong to the vegetable or animal kingdom, the body you employ need not be

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near so ponderous; though it ought to be more so than water; because (as I found by trials purposely made) some liquors, that are very spiritous and volatile, are yet much heavier in specie than water. It is not very easy to pitch upon such a single solid, as may have all the qualities, in reference to our purposes, that may be desired in it, if it be to be made use of for a long time. For thirdly, besides that, it ought not to lose of its weight (and consequently to change it) by the insensible avolation of effluvia, and that it must be, as was freshly noted, of a considerable specific gravity. Fourthly, it ought not to be too big, or too intensely heavy, lest it be too heavy for a tender balance, or require too much liquor to environ it. Fifthly, it ought to be of such a texture as not to be dissolved, or corroded, by any of the several liquors, some of which may be sharp and piercing menstrua, that it is to be weighed in, and those too of differing natures. Sixthly, it should also be of such a make, as is not easily liable to be broken, or otherwise spoiled, that it may last till all the designed experiments, though many, be made with it. Seventhly and lastly, it is desirable, that it should be of a natural and uniform, as to sense, and procurable substance; that the experiments made with it may be easily enough communicated to others, and, if they think fit, tried over again by them; and that, if any be judged worthy, they may be transmitted to posterity.

SEVERAL bodies there are, that I looked upon as more fit than most others to be employed about the trials we are treating of. The chief of these were brimstone, hard wax, ivory, and white marble. But though each of these, especially if fitly shaped, may be of use on some particular occasions; yet every one wanted some of the desirable qualifications lately mentioned. And therefore, I made much more use of three other bodies, not because they were such as I could wish, but because they were the least remote from being such, among those I could procure. The first of these was a piece of amber between three and four drachms in weight, of an high yellow colour, but very transparent, and of an uniform texture and convenient shape. This was judged fit to be employed, when we were to examine the lighter sorts of liquors, such as common water, rain-water, &c. wine, brandy, rectified spirit of wine-vinegar, and the liquors drawn from it, cyder, beer, ale, urine, many waters and spirits distilled from bodies belonging to the vegetable and to the animal kingdoms. But it is not proper for the more ponderous kind of liquors, since it will not sink to the bottom, but float at the top, not only of some liquors of the mineral kingdom (as will ere long appear) but in several liquors afforded us by the saline parts of bodies belonging to the vegetable kingdom; as you will find within a few pages.

THE second body I employed was a globular glass, which I caused to be blown at a lamp, and to be hermetically sealed at the neck, which was purposely made very short, after there had been lodged in it as much quicksilver, and no more, as we guessed would serve to sink it in any liquor, except quicksilver. This, by reason of its great bulk, in reference to its weight, was fit to discover differences in weight minute enough between the liquors it was weighed in; and it was out of danger of being corroded, even by sharp menstrua; and therefore, on divers other occasions, I preferred this instrument to any of the other two: but it is disadvantaged by these inconveniencies, that it is difficult to be made, or procured; that it is hard to be preserved, being very easy to be broken; and that partly on this account, and partly on others, it can scarce be a fit standard in reference to such observations, as are to be communicated to others, and transmitted to posterity.

WHEREFORE for experiments, that are to be imparted and recorded, I made use of a solid, which, though heavier in specie than was necessary to enable one to com-

pare together the lighter sorts of liquors, and to discover their minuter disparities in point of weight, is yet a natural standard, not subject to be broken without gross negligence, nor to be dissolved or corroded by the liquors it was to be immersed in, however of various kinds, and very sharp, and ponderous enough to sink in all of them, except quicksilver, and yet not near so ponderous, as the lightest metals, or many metalline bodies. This solid I speak of is rock-crystal, which I formerly represented, as for its purity, homogeneity, &c. fit to afford a measure, to which other bodies may be compared in weight, and by that means among themselves. And of this pure concrete we employed an almost complete globe (weighing in the air 3ii. 3ß. grains 3.) save that it had in one part of it two small holes near one another, and easily stoppt up with hard wax, after there had been put through them an horse-hair, by whose means the ball was easily fastened to the scale, from whence it was to hang in the water. The bigness of this globular body made it the more fit to discover the lesser differences between liquors in point of intensive gravity. But because we may have oftentimes occasion to know the weight of liquors, of which, by reason of their preciousness, or rarity, we can command but small quantities, as it frequently happens, if we be to try the weight of chemical oils, tinctures, essences, &c. we thought fit, for such liquors, to provide a piece of crystal, such as nature had framed it, *viz.* an hexagonal prism, with a kind of pyramid at the end, which is opposite to the extreme, at which it was broken off from the body it grew on. For this clear and finely shaped crystal (or what is very near of kin to it, white amethyst) by reason of its oblong figure, might be commodiously weighed in so slender a cylindrical glass, as required but a small quantity of liquor to cover and surround a conveniently shaped body, that weighed, in the air, but half an ounce and sixteen grains. And to render the observations, made with these two bodies of medicinal and other liquors (for there are several of these trials, that belong not to this tract) the more useful to experimenters, I shall here desire you to take notice, once for all, that the ball of crystal was to water of the same bulk, as $2\frac{5}{100}$ to 1, or thereabouts; and the prismatical oblong piece of crystal was, to a quantity of the same liquor, equal to it in magnitude, as $2\frac{5}{100}$ to 1.

I HAVE the more particularly delivered the way of exploring the gravity of several liquors with one solid, because there may be made of it a couple of applications, that may, on several occasions, be of use, not only to chemists, physicians, and apothecaries, but to divers other experimenters, that are not of either of their professions.

THESE applications do, I confess, belong to another paper, (*viz.* an essay about some uses of chemistry improved) that was written divers years ago. But since, by reason of the loss of divers leaves of it, I know not whether, much less when, it will come abroad, I shall at present borrow some few things of it to accommodate my present design.

FIRST then, the piece of clear amber formerly mentioned, or some such convenient body, that is not too little, nor *in specie* too heavy, may serve the chemist, apothecary, and others, to make probable guesses of the degree of spirituousity, or of thinness, that is to be found in many liquors belonging to the vegetable or the animal kingdom, which may be done with far less error by this way, than by those uncertain signs, on which the common ways of guessing are wont to be grounded. For having once provided a liquor, by comparison whereto one may safely make estimates of others of the same kind, or denomination, it will be easy, by observing the differing weights of the amber in several liquors to judge of the fineness of any of them in its kind; for, *ceteris paribus*, that is the thinnest, or abounds most in

spirituous parts, where the solid weighs more than in the other, as for instance, the amber we employed, that in water weighed $6\frac{1}{4}$ grains, in common red French wine weighed $8\frac{1}{2}$ grains, in common brandy of a pretty good sort, such as that of *Nantz*, $17\frac{1}{8}$ grains, and in vinous spirits highly rectified $34\frac{1}{8}$ grains. The same way one may employ to judge of the strength of spirits of vinegar, *acetum radicatum*, &c. but with a great difference in the application. For it may pass for a general rule, that it is probable, that of liquors distilled from wine, cyder, ale, and other fermented liquors, the hydrostatical body (if I may so call it) weighs more or less, according as the liquor it is weighed in is more or less spirituous; but, on the contrary, in acid spirits and liquors; the less the solid weighs, the stronger one may repute that liquor to be: that greater decrement of weight proceeding usually from the greater proportion it contains of salts, that are not volatile.

I MUST not here pretermite one convenience of the way newly proposed, that may, in tract of time, save you some money, and, at least, will enable you to husband better, than in the vulgar method you can, liquors, that you may have but small quantities of, or that are worthy to be preserved. For, you know, it is usual with many chemists, and especially those, that are more circumspect than others, to try the goodness of their spirit of wine, or brandy, or other spirits drawn from fermented liquors, by setting fire to a spoonful of the spirit to be examined, in order to see how much of it is totally inflammable, and how great, or little a portion of phlegm will be left behind. But, not here to mention the scruples I propose in another paper, about this way of trying ardent spirits, I shall now only take notice, that, by the newly recited way you lose or spoil all that you try, and the better the spirit is, the greater is your loss; whereas by the hydrostatical way, the liquor is examined without being destroyed.

IT is now fit to add, that by the help of the foregoing observations, one may also make estimates of liquors of the same kind not distilled, whether fermented or not fermented, as several sorts of beer, or of ale, or of cyder, or of juices of apples, or of pears newly pressed out. And the same hydrostatical solid may be employed, to compare with one another, in point of intensive weight, liquors of differing kinds, as wine, beer, ale, mead, cyder, perry, verjuice, expressed oils, essential oils of different bodies, &c.

BUT, in case the liquors to be employed be very ponderous, amber will not be a fit solid to be examined about them; for I have found by trial, (what one would scarce suspect) not only that it would swim or float in divers liquors made by solution of salts, whether in the moist air, or even in water, such as oil of tartar per deliquium, solution of salt of tartar in as little water as may be, and solution of the salt of pot-ashes, &c. But some distilled liquors would not suffer my pellucid amber to sink to the bottom, as I found by trial made with oil of vitriol, with spirit of nitre, and even with good spirit of salt.

BESIDES, there may be another use made of our hydrostatical solid, which may, on divers occasions, be as serviceable to experiments in general, by assisting them to proportion to their purposes, the strength of the menstruums, and other liquors they are to employ, as the former use is to distillers and apothecaries, for discovering the strength of the already prepared liquors, that they would examine. For there are divers experiments, that either do not succeed, or at least do not succeed so well, unless the menstruums, or other liquors employed in making them, be of a determinate degree of strength, (which is usually knowable by a certain degree of intensive weight.) This will be the more easily granted, if (as I have elsewhere shewn) the strength and spirituousity even of some liquors, whose chief virtue and

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use is to be good solvents, may yet be unfit to dissolve, as well because their strength exceeds a certain measure, as because by their weakness they fall short of it. Of this, I remember, I gave an instance in aqua fortis, whose strength, as its name intimates, is reckoned the best quality it can have; for I found that if it were ratified so much as to make it as strong as we could, or but somewhat less strong than that, it would not dissolve silver, but required to be weakened by an addition of water; and I found that the menstruum, though it were not much rectified, would not near so well dissolve the filings or raspings of crude lead, when it was moderately strong and fit to dissolve silver, as when it was allayed with a considerable quantity of water, especially if afforded by rain, or by distillation. I shall add, that in making extractions from many vegetable substances for medicinal uses, chemists themselves may fall into a mistake, when they affect to employ their most rectified spirit of wine, as the best menstruum for their purpose: for the medicinal virtue of not a few such bodies does not reside only in what chemists call their sulphur, and might perhaps more properly be called the resinous part, which indeed is best dissolved by such spirit of wine as is carefully dephlegmed; but also in a more gummous, and partly perhaps almost mucilaginous substance, for whose extraction a moderately phlegmatic spirit is more proper, because of the aqueous portion, that is mingled with the inflammable one; since we see, that some gummous bodies, as gum arabick, gum tragacanth, &c. are not disposed to be dissolved by the best rectified spirit of wine, as they are by aqueous liquors, as water, weak spirit of wine, &c. and some, though dissoluble in both kinds of menstrooms, are yet less easily so in strong spirit of wine, than in waterish menstrooms, as may be observed particularly in myrrh; for other instances applicable to these advertisements belong to another paper.

AND what has been now said may serve to persuade you, that it may be of good use, on divers occasions, to take notice of the degree of strength of the menstruum, or other liquor, we employ about this or that nice experiment; that when we have occasion to reiterate it to the same purpose only, we may be able to bring the liquor we make use of to the same degree of strength with that which we formerly employed, and by which the designed effect was produced. But in experiments, that should be very critically made, it will not be amiss to bear in mind this caution, that if the liquor be very ponderous in specie, as oil of vitriol, or oil of tartar per deliquium, it will be fit to put something into the scale, from which the solid hangs, to make compensation for that part of the hair, that is immersed, since horse-hair not being of the same specific gravity with this liquor, (though it be presumed to be so with common water) is to be considered as a somewhat lighter body, capable of buoying up the solid a little, and therefore its comparative levity should be compensated.

C H A P. XII.

BESIDES the way we come from discoursing of, there is indeed another way, which we have, on divers occasions, found useful to compare different liquors, that are of the same magnitude in point of weight. This is done by successively filling a vial greater or smaller, furnished with a pretty long and slender cylindrical stem, to a certain stable mark made near the top, with the several liquors to be compared together in point of gravity.

BUT this way I must here do no more than name, not so much because I speak of it in a convenient place of another paper, as because it is not hydrostatical. But

there is also another way to discover, whether or no two or more liquors proposed differ in specific weight, and to make some not groundless estimate of their differences. This is done by a hollow cylinder of brass, or other metal, made somewhat heavy at bottom to make it swim upright, that sinks more or less in several liquors, as they are lighter or heavier, one than another. But the diligent *Mersennus* himself, who proposes this way, confesses it to be very difficult to make sure observations by it. To which I shall therefore add but this, that being a metal, it may be corroded by acid menstruums; and if it be of brass or copper it may be wrought upon or injured by urinous menstruums too.

WHAT *Mersennus* said of this instrument, may be applied to another, though differing from it both in shape and matter. For it is made of two glass bubbles, and a very slender stem, which is hermetically sealed with a ballast in the lowermost of quicksilver to keep it steady, when partly immersed in liquors, in which this instrument, like the metalline cylinder, sinks deeper in lighter liquors, than in heavier; in a measure somewhat answerable to their differences in gravity. But, though I have, on several occasions, employed these instruments, and found them not unuseful, when I did not confine myself to one or two, but made use of several different sizes, according to the various liquors I was to examine; yet what you may elsewhere find about this instrument, dispenses me from saying any more of it in this place, than that for some of the ends aimed at in this chapter, it is inferior to the way of examining liquors by the help of the balance.

THERE is also another way, that is hydrostatical, proposed by *Mersennus*, of weighing of liquids in water, and it is this: he bids you take a glass vial, to which, being first weighed in air, and then in water, you are to adjust a stopple of wax, or cork, that will fit it exactly. This done, you are to fill the vial with the liquor you would examine, so that no air be left between it and the stopple. The vessel thus filled you are to weigh in water, and subtract from its weight there, the formerly noted weight of the glass itself in water, and also that of the stopple; which done, the remains will give the weight of the liquor proposed in water. This method I lately chanced to find propounded by (the writer newly named) the industrious *Mersennus* in his *Hydraulicks*; but I remember not, that he affirms himself to have made use of it; and though it may be serviceable on some occasions, yet I fear it will be troublesome in practice. For (to omit some inconvenient circumstances) ordinary vials, capable of containing a competent quantity of liquor, are usually too heavy to be employed with tender balances; and common stopples (such as *Mersennus* may be well supposed to have employed) will be subject to divers inconveniencies, as that they may be penetrated by some liquors, and corroded by others; and if they be made of cork, or of common wax, or any other substance lighter in specie than water, it will not be easy to find its specific gravity, especially since evaporation and other accidents make this itself vary; and whatever matter vegetable or animal, it be made of, the vessel will cost you two operations, one to discover the weight of the vessel in water, and the other that of the stopple, (at that time) which is troublesome. Wherefore, when I met with this way in the ingenious *Mersennus*, it seemed to me more inconvenient than one, that I remember I had formerly thought of, and which I have sometimes put in practice, by chusing a vial not too large, and of a round figure, that being the most capacious under such a superficies, and instead of other stopples, fitting it with one of (the like) glass, carefully ground to the neck of it. For by this means the inconveniencies of a stopple lighter than water were avoided, nor would the stopple alter its specific gravity, either by imbibition, or evaporation; nor would it be penetrated by the most subtle spirits, nor corroded by
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the most fretting ones. To which may be added, because in some cases it may be considerable, that a glass stopple, as it will not be wrought on by the liquor contained in the vial, so it will not communicate any tincture, or extraneous quality, to the liquor; which cannot be affirmed of a stopple of cork or wax, in reference to some subtil and very corrosive, or other very penetrating liquors: this hydrostatical bottle (as for distinction sake I call it) being together with its stopple carefully weighed, first in air, and then in water, (that the gravity of the whole instrument in that liquor may be settled once for all) we filled it exactly with the liquor to be examined, and so proceeded, as if we were to weigh quicksilver according to the manner formerly declared in the eighth chapter. The weight of the given liquor in water being thus obtained, its proportion in weight to water of the same bulk may be easily discovered by the way formerly delivered in the second chapter (or the tenth chapter.) This way of examining liquors may, on some occasions, do good service; and I did the rather now and then make use of it, because it is applicable to all kind of liquors, whether heavier in specie than water, or lighter.

If you lay aside the stopple, the round ball itself may be made use of on several occasions, instead of that hydrostatical bucket formerly mentioned; for the weighing of quicksilver, and divers heavy powders, especially if they be coarse ones. But if the instrument be fitly shaped, and not too heavy, there may belong to it a greater conveniency than this. For when you have, and are willing to spare liquor enough to environ the little bottle, it may be usefully substituted to the hydrostatical bubble, with quicksilver enclosed, that I formerly recommended. For by reason of its exact stopple, it has no need of an hermetic seal, (which is not easy to be made or procured) and it is far less subject to be broken than a bubble. And yet that which I most made use of (and which weighed about ℥i. ʒiiiss. grains xix. or 709 grains) being well stoppt with only air in it, would sink by its own weight in water, and in liquors lighter than this, as wine, brandy, &c. And if it were to be employed in liquors much more ponderous than water, as aqua fortis, oil of tartar per deliquium, &c. it was easy to make it fit to be weighed in them also, by putting into it a quantity of quicksilver (or some other fit body) of a determinate weight, as two, three, or four drachms, before we stopped it: which ballast, when the operation is over, may, if it be quicksilver, be easily taken totally out, and kept apart for the like uses: and the empty bottle and stopple may thereby become fit again, to be weighed in water and lighter liquors.

BUT notwithstanding all this, because glasses, for size, shape, and weight, fit for balances, tender enough, and furnished with glass stopples exactly fitted to them, are very difficult to procure; and the way itself is subject to some of the inconveniencies that we imputed to other ways, not long since mentioned: it seems, that generally speaking, this way of finding the weight of liquors in water, is inferior for common use to those more simple ones that we formerly recommended. See the chapter.

C H A P. XIII.

HAVING now laid down the method of weighing one liquor in another, it use VI. is allowable, and may be fit, that we subjoin some application of it; especially because it will become me to make good, in some measure, what I remember I formerly hinted to you, *viz.* that in the subsequent part of this paper, there would be delivered a further use, which may be counted the sixth of the hydrostaticks in examining medicinal bodies. And though by the instances we lately had occasion to propose in some of the chapters preceding this, divers things referable to this use are set

set down already; yet I should not content myself (as I now must do) to point at the chief heads or kinds of things referable to it, if on a subject that is more fertile than it seems, want of leisure did not restrain me from descending to treat of the particular instances that belong to them.

AMONG the services then that the hydrostaticks may do a sagacious physician, I must not omit one, though it has not hitherto, that I know of, been propounded by any author. And, I hope, you will not think it improper to be taken notice of here, though it do not regard only the *Materia Medica*, but is applicable (as I may elsewhere relate that I made it) to divers subjects that are referable to other parts of physiology: since divers bodies that seem not so directly to regard the *Materia Medica*, as it is usually repositied in the shops of drugsters, have been in some times and places, and may deservedly be now made to afford matter for remedies to a free and ingenious physician.

I CONSIDER then, that there are many liquors, whose specific gravity it may be useful to know, not only as it may help to distinguish genuine or well-conditioned ones from them that are not so, but for other good purposes too.

INSTANCES of this kind may be afforded by the juices of herbs and fruits; where (according to the direction given in the last chapter) we first weigh a determinate quantity, as an ounce, or so many drachms in our hydrostatical jar, or bucket; and putting some oil of turpentine on it, we sink it warily into that liquor, whose specific gravity, in reference to refined silver, clear rock crystal, (or some other body, if we know it to be as pure) has been carefully found out and registered: for by this means (as we have lately manifested) substituting this oil for common water, we may discover the specific gravity of liquors, not to be weighed in water, because they mingle with it. And thus we may find, not only the difference in ponderosity between the juices of plants of different kinds, as of wormwood and roses, and sometimes of the subordinate species of the same genus, as absinthium vulgare, ponticum, romanum, &c. and roses, white, red, damask, yellow, &c. but we may on some occasions observe, whether, and if at all, how far the keeping of a juice for some time, more or less, or the fermentation of it, or the putrefaction, will alter its specific gravity. There are also other liquids used by physicians, and not ponderable in water, that may be by this way examined, as honey, vinegar, verjuice, &c. And by the same way may be also discovered and compared, the specific weight of the juices of fruits of different kinds, as of grapes, apples, pears, quinces, &c. and of subordinate species belonging to the same genus, as the newly expressed juices that make sacks, French-wines, rhenish-wines, &c. and those liquors that are pressed out of several sorts of apples, as pippins, pearmain, John-apples, queen-apples, &c. And in divers of these, a person that is curious enough, may probably, by the method we have been proposing, be enabled to take notice of the differences produced in the specific gravity, (whose changes are usually accompanied with those of consistence, &c.) in the several successive states, wherein the liquors may be found at different times, as (not to mention the juice of unripe grapes, viz. verjuice) the juice of ripe grapes is in very differing states when it is newly pressed out, when it begins to ferment, when it is yet but new wine, when it has attained its full maturity and perfection, when it begins to degenerate into ropy pricked wine, &c. and when it is absolutely changed into vinegar, or else into vappa.

BUT here it ought not to be concealed from you, that in this kind of experiments, to make use successfully of the hydrostatical bucket, is a task difficult enough, for reasons that a few trials will easily discover. And therefore, though I would not discourage the skilful, yet for those that do not find themselves dextrous at making experiments,

experiments, I think it adviseable to employ, instead of the bucket, amber, or some other convenient hydrostatical solid, or rather (which is better) a glass bottle and stopple, such as we formerly described, but as large as may well be employed without overloading or injuring the balance.

C H A P. XIV.

AS I thought it was fit to give the foregoing advertisement by way of caution in the cases that occasioned it; so having considered the nature and scope of the hydrostatical experiments in general that belong to this essay, I shall venture to add for the encouragement of those that are better furnished with inquisitive minds, than with nice balances; that though in divers trials, especially those that are made about precious things, as gold, pearls, diamonds, and other gems, there is no relying upon any but very good and tender balances; yet, on many other occasions, it is not necessary, though it be desirable, that the scales we employ should be extraordinary good. And this for two reasons: first, because many hydrostatical experiments are such, that a little variation from the exact proportion of the solid to the liquor, or between bodies of the same denomination, can lead us into no considerable error, or at least not defeat the experimenter's main design; as with a balance that is not nice, one may sufficiently distinguish between an human calculus and a pebble, or other ordinary stone, and between coarse and fine native cinnabar: and between a true guinea, or other piece of coined gold that is not very small, and a counterfeit one of brass, or any such mixture, though never so finely gilt.

AND secondly, because as there are few physical experiments, wherein mathematical preciseness is necessary, and fewer wherein it is to be expected; so in many hydrostatical trials, it is very probable, that the difference of bodies of the same kind, or denomination, flowing from their compositions and internal textures, will make a discernable, though but small difference in their specific gravity: as in rock-crystal itself, we have found some pieces to be to water, as $2\frac{1}{2}$, or a little more to one: and others to be to the same liquor as two to six, or between six and seven tenths to one. And therefore, how exact soever the balance be, there must be some allowance made for the diversity that may be found in the bodies themselves that are examined, which diversity may perhaps produce, at least, as great difference in the proportions we seek for, as needs to be expected from a small difference of tenderness in the balances we employ. And indeed, neither one of those differences, nor the other, (nor perhaps both together) is wont to be so considerable, as to challenge much regard in physical experiments; or at least, as to hinder it to be true, that on most occasions, the hydrostatical way of examining the specific weight of bodies, is preferable by far to any other way of doing it that has been practised.

BEFORE I proceed to the remaining part of this essay, it will be worth while to obviate an objection, that I foresee may be made by critical naturalists against the method hitherto delivered, of finding the proportion in weight betwixt a sinking body; and water of the same bulk. For it speciously may, and probably will be objected, that by this method we cannot discover the proportion between a solid body, and water in general, but only betwixt the proposed body, and the particular water it is weighed in; because there may be a great disparity betwixt liquors that are called, and that deservedly, common water. And some travellers tell us from the press, that the water of an eastern river, which if I mistake not is *Ganges*, is by a fifth part lighter than our water.

BUT to this plausible objection, I have two things to answer.

AND

AND first, having had upon several occasions the opportunity, as well as curiosity, to examine the weight of divers waters, some of them taken up in places very distant from one another, I found the difference between their specific gravities far less than almost any body would expect. And if I be not much deceived by my memory, (which I must have recourse to, because I have not by me the notes I took of those trials) the difference between waters, where one would expect a notable disparity, was but about the thousandth part (and sometimes perchance very far less) of the weight of either. Nor did I find any difference considerable in reference to our question, between the weight of divers waters of different kinds, as spring-water, river-water, rain-water, and snow-water, though this last were somewhat lighter than any of the rest. And having had the curiosity to procure some water brought into *England*, if I much misremember not, from the river *Ganges* itself; I found it very little, if at all lighter than some of our common waters.

AND now I shall represent in the second place, that I do not pretend, (and indeed it is not necessary) that the proportion, obtainable by our method, should have a mathematical preciseness. For in experiments where we are to deal with gross matter, and to employ about it material instruments, it is sufficient to have a physical, and almost impossible to obtain (unless sometimes by accident) a mathematical exactness, as they will scarce deny, that have, as I have done, considered and made trial of the difficulties that oppose the attainment of such a preciseness.

C H A P. XV.

Hydrostatical Stereometry applied to the Materia Medica.

S E C T. I.

THERE is an use of hydrostatics, which though it do not directly tend to the examen of drugs, or simples received into the *Materia Medica*, yet may be serviceable both to the physician and the naturalists, in delivering their descriptions; and so it may indirectly conduce to the knowledge of them, and help, on some occasions, to distinguish between genuine simple (especially fruits) and those that are not so; it is known that the writers of the *Materia Medica* are wont to set down the bigness of the bodies they describe by very uncertain guesses; and those that to be more accurate, assign them determinate measures, are wont to do it, by saying, that such a fruit, or other body is, for example, an inch, or two inches, or half a foot long; and half an inch, or a whole inch, or two inches and an half in breadth. But it is obvious to those, that are not great strangers to the mathematics, that according to this way of describing bodies, there may be, by reason of the great variety of figures they are capable of, especially irregular ones, a very great disparity of magnitude, or bulk in bodies, to each of which the same length and breadth may be long or be applied.

I SHOULD here be able to present you an hydrostatical way of determining the bulk of bodies, both much nearer the truth than that newly recited, and grounded as well on experiments as mathematics; if among other papers, I had not unfortunately lost one, that I wrote many years ago, about the measuring of solids, by the help of liquors. But though I cannot, out of my memory, recover the theoretical part of that writing, (whose loss I regret, because it had been examined by one of the exactest, as well as famousst mathematicians of our age, whom I invited to be

present at the chief experiments) yet I think I can call to mind as much of the practical applications of it, as may suffice for my present purpose.

THE ground of the way, I am about to propose to you, will be easily understood by the following (though but short) account. I caused to be carefully made, by skilful artificers, several cubes, both of different sizes and different materials, as marble and metal; whose sides were each of them, as near as the artist could make them, either an exact inch, or precisely more inches than one, according to our *English* measure, which is said to differ very little from the correspondent one of the old *Romans*. These cubes were carefully weighed in trusty balances: first, in the air, and then in common water. And though I found some little (and but little) difference, between the products of the trials; yet that difference being no more than might reasonably be expected from the scarce avoidable imperfection, even of good artists, and their tools; we concluded that one might, without any considerable error, take a medium (as they speak) between these products, and allow, even to this medium, a latitude of some grains; since that latitude will not amount to the sixtieth part of the weight of a cubical inch of water. Since therefore some of our trials inclined us to judge, that about two hundred and sixty; and some others to think, that two hundred fifty two; and others again, that about two hundred fifty six came nearest to the true weight of a cubical inch of water; we thought ourselves at liberty to make use of that number, that should appear most commodious for practice, by reason of its divisions and subdivisions into aliquot parts, especially if the body to be examined were not great; since in that case, two or three grains, more or less, would not be considerable, especially in a physical experiment, where geometrical exactness is not to be expected nor indeed required, and a far less accurate estimate will be less unaccurate, than can with any certainty be made by the formerly mentioned way of judging by the length, breadth, and depth (or thickness) of the body proposed.

I MADE the less scruple to pitch upon the last of the three forementioned numbers of grains, not only because it affords many aliquot parts for a number that is no greater, since barely by a successive bipartition it affords seven such parts, *viz.* 128. 64. 32. 16. 8. 4. and 2. but because I was encouraged by an experiment differing from those already mentioned. For having caused to be purposely made by a good artist, an hollow cube of brass, whose cavity was fitted to contain a just cubical inch of matter, (either solid or liquid) we put it into one scale of a tender balance, with a just counterpoise in the other, and placed it there as horizontally as we could. Then we warily put into it, little by little, as much common water as it would contain, without either overflowing, or having its surface manifestly turgid; putting also, from time to time, in the opposite scale, small weights, to keep it from swerving too much at once from an æquilibrium. And though it is extremely difficult in practice, to discern with certainty, when the vessel is so exactly filled, that a drop, or even two or three drops, more or less, cannot be added, or taken away, without being observable by the eye; yet, for this very reason, we thought our experiment agreeable enough to our supposition, when we found, that, by so light an alteration, the weight of the water, when the scales were heedfully counterpoised, amounted to near about two hundred fifty six grains, which number we shall therefore hereafter employ, as expressing the weight of a cubical inch of water.

AND now to apply the past discourse to our present purpose.

SUPPOSE, for example, that a solid, heavier in specie than water, having been weighed first in the air, be found to lose of its weight in the water $\frac{3}{8}$. sixteen grains, that is two hundred fifty six grains, I say, that the dimensions of this solid, if it were of a cubical shape, would make it equal to a cubical inch: so that (to express the

thing yet more clearly) if the given body be supposed to be an easily fusible metal, as tin, or lead; and, being melted, to be warily poured into the hollow cube formerly mentioned, and suffered to cool, it would just fill it and no more, and consequently be a cube of metal, whose length, breadth, and depth, are equal to one another, and each of them to an inch. For as it is a fundamental theorem in hydrostatics, demonstrated mathematically by *Archimedes*, and elsewhere physically by me; that *a sinking solid weighs less in water than in air, by the weight of as much water as is equal to the solid in bulk*; and since we have lately shewn by experiments, that a cubical inch of water weighs ℥℥. 16 grains, that is, 256 grains; it will follow, that when the decrement of a body's weight in water is found to be 256 grains, the solid content of that body is a cubical inch: since an aqueous body, weighing 256 grains, is equal in magnitude, as well to the solid propounded, as to a cubic inch of water. And here it may prevent a scruple, to observe, that to make bodies equal in magnitude, it is not at all necessary, that they should be of the same weight, or of the same matter, as is evident in bullets of copper, tin, and gold, cast separately and dextrously in the same mould. For though they be equal in bulk, yet the bullet of copper will be much heavier than that of tin; and the bullet of pure gold will be more than twice as heavy as that of copper. Whensoever therefore you meet with a solid, ponderous enough to sink in water, that, being weighed in that liquor, loses 256 grains of the weight it had in the air; you may conclude the magnitude or bulk of that body to be equal to a cubical inch, of whatever matter it consists, or of what shape soever, regular or irregular, it be. And in case the solid proposed do (as it will very often happen) lose of its weight in the water less than 256 grains, you may conclude its bulk to be proportionably less than a cubical inch. And such is the conveniency of the number we have pitched upon, which abounds in aliquot parts; that every 32 grains, that the solid loses of its weight in the water, answers to an eighth (that is, half a quarter) of an inch in the bulk of the body: as if the decrement be 128 grains, the solid will be half a cubic inch; and if it be but 64 grains, it will be but a quarter of a cubic inch; and so if it be 160 grains, it will be $\frac{5}{8}$, that is, half and half a quarter of an inch cube: and on the other side, if the decrement of the given body exceed the standard, *viz.* 256 grains, twice, thrice, &c. then that decrement being reduced to grains, as suppose it weigh $\text{℥j.} + \text{grains } 32$ (amounting to 512 grains) or $\text{℥j. ℥.} + \text{grains } 48$ (amounting to 768 grains) the body will be equal to two or three (single) cubical inches. And, if after the division there remains a fraction, it will not be difficult to estimate it to him that considers what has been newly delivered.

S E C T. II.

TO discover hydrostatically the solid contents of a body heavier in specie than water; to him that knows how to make use of the method newly delivered, it will not be very difficult. But to measure, by the help of water, the solidity of a body lighter in specie than that liquor, is a work not so easily performed. It may somewhat lessen the difficulty, to premise, that there are two sorts of bodies, that will naturally not sink in water. For some are of a closer texture, and will not be easily invaded by that liquor; at least, in so short a time, as they are of necessity to be kept in it: and others abound with pores, that dispose them to imbibe the water they must be kept immersed in till the experiment be dispatched.

To begin with the first sort of bodies: it is known to hydrostaticians, that, according to a theorem of *Archimedes*, the weight of a body, belonging to that kind, may be

be gathered from the weight of the water, that is equal in magnitude to that part of the body that is immerled in that liquor, when the solid floats freely upon it; as, if a parallelipedon, or a cylinder, of wood, twelve inches long, being placed upon water, should rest there, when a twelfth part of it lies beneath the surface of the liquor; in this case, the weight of the water, equal in bulk to that immerled twelfth part, would be equal to the weight of the whole wooden body. But because the bodies, whose bulk physicians and chemists may have occasion to examine, will very seldom happen to have shapes so near those of regular ones; it will scarce be worth our while to enlarge upon this way of estimating light bodies; which will be so troublesome to make fit for most mens practice, that, unless it be desired, I shall not trouble you with it; but forthwith proceed to what will conduce far more to our present design, which being to measure the solid contents of bodies, not so heavy (intensively) as water, and for the most part irregularly shaped; it will be necessary that we employ a method differing from what we have hitherto made use of. In the first step of this, though not in the second, we may be helped by the industrious *Mersennus*, who probably borrowed his way of *Ghetaldus*, from whose *promotus Archimedes* he professedly borrows many things.

BUT because that, on this occasion, *Mersennus*, affecting brevity, hath made himself obscure; so that what he writes can scarce be understood, but by mathematical perusers; I shall, for the sake of another sort of readers, deliver the propounded method, though not in so few words, yet more clearly and orderly. First then, you shall weigh in the air the body (lighter than water) to be examined. Secondly, you shall take a plate of lead capable of making this body sink with itself in water, and of some weight, not incumbred with fractions, as just a dram, half an ounce, an ounce, &c. Thirdly, you must weigh this plate in water, and, by subtracting its weight in this liquor from what it weighed in the air, you must obtain a difference, which will give the weight of as much water as is equal in bulk to the immerled lead. This, for distinction's sake, may be called the specific weight of the lead in water. Fourthly, you must tie together (which you may best do by one or more horsehairs) the plate of lead, and the lighter body, and note the weight of the aggregate, which, as you know, is nothing but the sum of the respective weights of the lighter and of the heavier body. Fifthly, you must weigh this aggregate in the water, and subtract its weight in that liquor, from the weight that the same aggregate had in the air, and the difference will be the specific weight of the said aggregate in water. Sixthly, from this difference subtract the formerly found specific weight of the plate alone in water, and the remains will give you the weight of the lighter body in the same liquor.

THUS far our author; without whose help we may easily dispatch the rest of our work, by the method employed already of measuring solids heavier than water. For the lately obtained weight of the light body in water, being (according to the method formerly proposed) divided by 256 grains, will give you the solid content of that naturally floating body.

BUT because a method, that is difficult enough to be put in practice by those that are not more than ordinarily well versed in hydrostatics, requires to be illustrated by an example, I shall subjoin an experiment, that may serve not only to clear up this practice, but in good measure to confirm it too; we took then a piece of oak conveniently shaped, and that weighed in air $193\frac{1}{2}$ grains. To this we tied with an horse-hair a plate of lead, weighing just half an ounce, *i. e.* 240 grains. But before we tied them together, the lead was weighed in water, where it lost of its former weight 20 grains, which, being deducted out of the 240 grains lately men-

tioned, left a difference or residue of 20 grains, for the specific weight of this piece of lead (for I have seldom found lead quite so heavy) in the water. Then the aggregate of the wood and lead was weighed, first in the air, and found to be $433\frac{1}{2}$ grains, and then in water, where it amounted but to 162 grains; which being subtracted from the aggregate of the same bodies in the air, the residue, or difference, was found to be $271\frac{1}{2}$ grains: from which difference the other difference of 20 grains (which had been lately found) of the leaden plate alone in the water being deducted, there remained $251\frac{1}{2}$ grains for the weight of water equal in bulk to the given piece of wood. If this number had amounted to 256 grains, of which it fell short but $4\frac{1}{2}$ grains, we might have concluded the solidity of it to be a cubic inch, since 256 grains of water, which we formerly found equal to a bulk of water of a cubic inch, was also now found equal to the bulk of the given piece of wood. And indeed, intending (as I formerly intimated) to give an example, that should not only illustrate (but confirm) the proposed practice, I caused the wood I employed to be formed into as exact a cube of an inch every way as I could procure from a joiner, that bragged of the pains he had taken about it: so that the difference of its weight in water from 256 grains, the weight of a full cubic inch of that liquor, may probably be imputed to some little imperfection in the figure of the wood, or some other light circumstance, not considerable enough to be much regarded.

Of this experiment one of my notes gives the following account.

I. THE oaken cube in air weighs (ziii. grains xiii $\frac{1}{4}$.)	_____	193 $\frac{1}{2}$
II. THE weight of the lead in air, (ziv.)	_____	240
III. THE weight of the lead in water (ziiiβ. grains x.)	_____	220
Which, being subtracted from its weight in air, leaves for its specific weight in water	_____	} 020
IV. THE aggregate of the two in air is	_____	433 $\frac{1}{2}$
V. THE weight of both together in water is	_____	162
Which, being subtracted from its weight in air, gives the difference of both the aggregates	_____	} 271 $\frac{1}{2}$
VI. THE difference between the weight of lead alone in air and in water, or, which is all one, the specific weight of the plate alone, viz.	_____	} 20
being subtracted from the difference of the weights of the aggregates in air, and in water, gives [for the weight of the cube proposed]	_____	} 251 $\frac{1}{2}$

THE way of measuring bodies, that has been hitherto delivered, is appropriated to such as will not at all (or, at least, will not readily) be dissolved in water. But because there are divers other solids, as lumps of salt, alum, vitriol, sugar, &c. whose magnitudes it may be fit for inquisitive men, of more professions than one, to know and to compare, I shall, to what has been already said, subjoin this advertisement; that the same way may be applied to measure the magnitudes of solids dissoluble in water, if, instead of this liquor, we substitute oil of turpentine, whose proportion and specific gravity to water we have found, or is otherwise known to us. When I first made this reflection, I had not such conveniencies, as when I found the weight of a cubic inch of water, to determine the weight of a cubic inch of oil of turpentine. But, having yet lying by me the hollow vessel of brass, whose cavity was an exact inch, that I employed to find out the weight of a cubic inch of water, I made use of it on this occasion too; and found, that when it was carefully filled with such oil of turpentine as we were wont to employ about hydrostatical experiments, the contained liquor amounted but to 221 grains, and an eighth (part of a grain)

grain) by which number the difference of the weight of a solid in the air, and in that oil, being divided, the quotient will give you the solid contents of the examined body.

AFTER so circumstantial an account as we have given of the way of hydrostatically examining such floating solids as, like the wood we employed, are of a texture at least moderately close, it may be seasonable, to proceed to the mention of the second sort of floating bodies, that I formerly told you might be proposed to be weighed in water; namely, such as, by their porosity or laxness of texture, are subject to imbibe too much of that liquor, even in as little time as is necessary for the dispatch of the experiment.

MERSENNUS* (more briefly than clearly) proposes an expedient in this case, which is, to cover over the body to be weighed in water with wax, pitch, or some other gluten, as he calls it, whose specific weight in water must be first known. But I take bees-wax to be much preferable to the other two. For pitch is so apt to stick to one's hands or clothes, that it is troublesome to apply it, and very difficult to get it off: and as for glues, most of them, especially the more common, are dissoluble in water, and therefore not so fit for the purpose as bees-wax (for that, I presume, he means by wax) which has this conveniency in it, that its proportion to water being usually constant enough, and the gravity of those two bodies differing but little, one may more easily dispatch a good part of the experiment; which is thus to be performed. Take the solid lighter than water, that you would examine hydrostatically, and having weighed it in the air, over-lay it carefully with a thin coat of bees-wax, so that no part of it may remain uncovered, or accessible to the liquor. Then take also in the air the weight of the wax you have employed, and fasten to the body, thus coated, a plate of lead, or tin, heavy enough to make it sink, and observe the weight of the aggregate in water. This done, subtract the weight of as much water as is equal in bulk to the wax, and proceed with the rest, as is before taught. *Mersennus* declares this practice by this instance, if the wax that invests the proposed body be of $\frac{3}{4}$ xxii. in the air, the bulk of water equal to it will be $\frac{3}{4}$ xxi. and therefore a quantity of water of $\frac{3}{4}$ xxi. must be first taken away, or subtracted, that the remaining bulk, equal to the (immersed) body, may, by its gravity, shew the gravity of the body (proposed) as has before been said.

BUT because the way above delivered can help us but to the knowledge of the weight of the proposed body in water, we must, to discover the solid content of it, proceed further than our *Mersennus* enables us to go; and therefore we must divide the weight of the solid in water, already found, by 256 grains, that by the help of the quotient we may obtain the solid contents of the proposed body.

I HAVE sometimes (to add that upon the by) thought of, and tried, another expedient, to hinder smaller solids, whether lighter or heavier in specie than water, from imbibing the ambient liquor. In order to this, I first found the weight of a cubic inch of quicksilver (which is not difficult to discover by its proportion to water of the same bulk.) And then we brought the body to be measured into a vessel, whose solid contents were known before: and thirdly, all that was not possessed by the firm body being filled with quicksilver, it was easy enough to know, by the difference in weight of that quicksilver from the weight of the quicksilver requisite to fill the whole vessel, to how much quicksilver the environed body was equal. And by this means, and the knowledge before gained of the weight of a cubical inch of mercury, the solid contents of the body proposed was not difficult to be obtained. But I forbear to give more than this intimation of an expedient, which, besides that

* In his *Phænomena. Hydraulica*, p. 185.

it belongs properly to another essay, is rather mechanical than hydrostatical. And, for the same reason, I forbear to set down one way of measuring the contents of irregular solids, delivered in some books of practical geometry; and another, but yet unpublished, way, differing enough from the former, that tends to the same purpose.

C H A P. XVI.

BUT, I perceive, that it is now more than time, that I should put an end to a labour, that has, I fear, tired you, because I am sure it has tired me. And yet I dare not conclude this tract without briefly answering a couple of questions, that, I foresee, may justly enough be asked me by a peruser of the foregoing essay.

AND first, I presume it may be demanded, ‘Whether I have proposed the best ways that can be thought of to examine bodies hydrostatically?’ To which question I answer, that, upon divers considerations, some of which have been mentioned here and there in the body of the foregoing essay, I did not think myself obliged solicitously to invent or propound new instruments for the hydrostatical examen of bodies. For though I am not ignorant, that divers more curious and artificial ways of finding out their weight in water, or their solid contents by it, may be devised by persons more skilful and sagacious than I: and though also I think it not unlikely, that, when the utility of such practices comes to be taken notice of, artificial instruments will be found out to facilitate, or otherwise improve them; yet I thought it became me at first to propound only the more simple ways of operating, as the most likely to invite the generality of those, for whose sake this essay is made public, and to require, for the main part of our experiments, only the use of the balance, as an instrument easily procurable, and already, for other purposes, in most mens hands, without mentioning, at this time, any more artificial instruments; though some of them are such as I have long since not only had thoughts of, but for my own uses practised; which intimation may be countenanced, if it were needful, by the mention of that little instrument, for distinguishing between true and counterfeit guineas, or the like pieces of coined gold, by the help of water; which was several years ago published in the philosophical transactions, and has since (without staying for my improvements of it) been made use of by some, and usurped by others. But of such things no more in this place.

HAVING answered the first question, it remains that I consider the second, wherein, though I shall aim at brevity as much as in the former, yet I fear I shall not be able to discuss it in as few lines as I did that. I presume then it will be asked, ‘What credit may be given to the estimates of the weight and proportions of bodies, obtained by hydrostatical trials?’ Since we see that though mathematicians, not knowing, or not applying, our observation about the specific gravity of rock-crystal, and the nature of oil, especially that of turpentine, have given us but the proportions of metals, and some very few other familiar bodies, as the loadstone, wax, honey, oil, and wine; yet those few that have not transcribed from one another differ, in the tables they have left us of the comparative weight of those few bodies.

THIS question is so comprehensive, that I think it cannot well receive a single answer; and therefore I shall offer two things to be considered about it.

AND first, I freely acknowledge, that there is no exact uniformity in the observations delivered about the weight of metals, and the other bodies newly named, among the few authors that have written of this subject; and there would probably have been yet more difference in their accounts, if some, even of those writers, had not avowedly

avowedly made use, to their purposes, of as much as they thought fit of the tables of *Ghetaldus*.

NAY, I shall not think it very strange, if I find that the experiments of the same man, made at distant times, and in other differing circumstances, should not all of them exactly agree. For I have already noted, and I think in more places than one, that there will scarce be found so great an uniformity in qualities, and particularly in specific weight, among bodies of the same kind or denomination, as there is generally presumed to be. There may be also some difference, though but little, betwixt the waters men employ, especially if the air be at one time (as in *July*) intensely hot, and at another (as in *January*) exceeding cold. The difference also of degrees of goodness of the balances, men employ about nice experiments, is not altogether inconsiderable. But there is a thing of greater moment than this towards the hindering hydrostatical experiments, and even statical ones themselves, from being so accurate as those that are not versed in such matters may require. The thing I mean is the difficulty of finding an exact uniformity in weights of the same denomination, which, for that reason, are vulgarly supposed to be exactly equal; but to know how far this supposition is to be relied on, it may at present suffice to set down some passages of a mathematician justly famous for his diligence, and who has made it his particular work to examine these matters scrupulously. The first passage that I shall alledge out of his writings shall be the short account he gives of many trials he made of natural grains, whence all sorts of weights have been deduced. * *Cum* (saith he) *omnia grana, vel semina, quæ reperiri solens in atriis venalibus Lutetiæ, ad stateram expendissem, vixque granum ullum inter ejusdem speciei grana grano alteri exactè respondisset, in incertis ludere nolui.* The same author informs us, that the Roman grains differ from the French grains, since, as he observes, 688 grains of the former sort are equiponderant but to 576 grains of the latter sort. And he subjoins, that, whilst he was writing these things, there was found, by the more exact weights of the mint, an error in the former estimate of at least half a grain in 36 grains.

AND elsewhere he † gives notice, that, by two relations sent him from *Rome*, about the number of grains contained in a Roman ounce, it appeared, that even that number varied, since one of those relations reckoned 612 grains in an ounce, whereas the other allowed it but 576 grains. And yet this I do not wonder at, because I have myself found it so difficult in practice to get and keep weights (for, as little as this is wont to be suspected, the very air may, in time, a little alter them) as exact as I desired, that I left off the hopes of it. And one remark, though commonly overlooked, I think too considerable to be here omitted. For whereas the accurate *Ghetaldus's* ‡ tables of the weight of metals, and some few other bodies, in reference to one another, are looked upon as the most authentic that have been published, and are accordingly made the most use of: it is certain, that the weights he employed are not divided, as ours are. For though indeed, according to him, as well as with us, the ounce consists of 24 scruples, yet the scruple, which with us is divided but into 20 grains, he divides into 24. But to return to *Mersennus*: a while after he had told us of the difference between his repeated trials and those of other men, in determining the weight of a certain body, he has this passage, which shews, that he was not over confident of the preciseness of all his own determinations: *Cum autem* (saith he, pag. 37. lib. 16.) *dixi, Chelinum, undecim dici denariorum, credunt tamen alii decem duntaxat, nil assero.*

* In præfatione ad librum de mensuris, ponderibus, & nummis.

† *Mersennus*, in the paper entituled, *Parisiensia pondera*, Coroll. 1, and 2.

‡ In the paper called *Galic. Nummis*.

HAVING gone through the first part of my answer, to the second query above proposed, it remains, that I proceed to the other part, which perhaps will not need more than the following reflection.

I CONSIDER then, that though it be granted, that hydrostatical experiments are not always either singly accurate, or exactly agreeable among themselves, yet they may well be both accurate enough to be of very good use, especially in practice, and less remote from being quite accurate, than any other ways that have been hitherto known to be practised of determining the proportions of bodies in point of weight and bulk, and of measuring the solid contents of stable bodies, whether heavier in specie than water, or lighter.

THE first part of this reflection may be deduced as a corollary from, or at least confirmed by, the greatest part of the foregoing essay. And indeed, as little skill as I have in hydrostatics, I would not be debarred from the use of them for a considerable sum of money; it having already done me acceptable service, and on far more occasions than I myself at first expected, especially in the examen of metals and mineral bodies, and of several chemical productions. And I have been able more than once or twice to undeceive artists and other experimenters, that, *bona fide*, believed they had made, or were possessors of, *luna fixa*, (as they call it) and other valuable things: and to make a good judgment of the genuineness or falsity, and the degrees of worth, or strength in their kind, of divers richer or poorer metalline mixtures, and other bodies, (some solid, and some liquid) whose fair appearances might otherwise have much puzzled (if not deceived) me.

BUT of this more may be found in another paper. For I must hasten to the second part of our designed reflection, by representing, that our hydrostatical methods of discovering the weights and bulks of bodies, though they may not be mathematically accurate, yet they are less remote from being so, than any way of mensuration of bodies, (especially such little ones as we usually have need to examine on the account of the *Materia Medica*) by the geometrical instruments, that are hitherto known to be practised; or, by the way, whereby the *tabula coitionis & expansionis materiae per spatia in tangibilibus*, &c. was framed by the renowned Sir * *Francis Bacon*, whose judicious reflections upon the rarity and density of bodies, such as their measures are delivered in that table, do sufficiently manifest, as the philosophical genius of the author, so the utility that may be derived from even such determinations of the bulks and weights of bodies, as fall short enough of being accurate.

I might here relate, that to convince some curious persons, how much hydrostatics may be made serviceable to as accurate a mensuration, as ought to be expected in physical experiments; I desired a virtuoso, first, to put together two lumps of metal, (*viz.* of tin, and of lead) in a certain proportion, that he was to conceal from me, but to set down in writing to prevent mistakes. Then I desired him to melt the metals (whose respective specific gravities I knew before) into one mass, and give me that mass. And thirdly, I weighed it carefully in water, and did also algebraically examine it. Which being done, I told him, that the lead he had employed amounted to such a weight, and the tin to such another; which being compared with the quantities he had committed to paper, the difference was found to be little more than one grain, and this itself probably proceeded from some scarce avoidable imperfection in the melting, pouring out, &c. of the given bodies. But because specious arithmetic was employed in this work, (to which yet it was not absolutely necessary) I shall lay no stress upon it; because, if I mistake not, the past discourse may suffice to give the hydrostatical ways of mensuration of bodies a pre-

* *Verulam in historiâ densi & rari, p. m. 8. &c.*

ference to their competitors, and may keep it from being presumptuous, to say, that they may be received as the best for practice, till some other more accurate, and yet as firmly grounded, and as practicable ways of accomplishing the same purposes, shall be proposed.

A P R E V I O U S

HYDROSTATICAL WAY

O F

ESTIMATING O R E S.

Addressed to the Secretary of the Royal Society.

A D V E R T I S E M E N T.

I KNOW there is a greater number of different kinds of fossils, than those that are yet known to belong to the *Materia Medica*. And, I confess, that the persons, which the following paper is chiefly designed to assist, are those that explore minerals with an aim not at health, but at profit. But yet I was content, that the ensuing discourse should accompany the foregoing essay, as a kind of appendix to it, because many of the subjects, about which both tracts are conversant, are the same; and the fundamental observation, (*viz.* about the specific gravity of crystal or marble) and the hydrostatical way of applying it in explorations, is the same in both: and also (and indeed chiefly) because I was made to believe, that it might, especially at this season, be grateful, and not unuseful to divers searchers after profitable minerals.

THIS paper (as the inscription intimates) was designed to be sent to the learned secretary of the Royal Society, when it was expected, that he would begin again to publish monthly the philosophical transactions, that had been long suspended, and as long desired by the curious. But since some accidents have occurred, that occasion a further delay of their publication, it was not thought fit, this paper (after having been long already) should be any longer confined to my closet. It is true, that this discourse, containing but an application of an hydrostatical experiment, I am far, as I ought to be, from proposing it as a treatise of the docimastical art, whose grand instrument is, the fire skilfully managed. For which reason I have forbore to set down in this paper, any of the flux powders, or other ways of examining ores, or of reducing them, or other fossils, to metals, or reguluses; that either say-masters are wont to employ, or I have devised, or tried upon minerals. But this, notwithstanding

our unpractised way of estimating ores, may not be useless; and for that reason, will not perhaps be unwelcome to some that love mineralogy, much better than they understand it: especially coming forth at a time, when many industrious persons of this nation are excited to look after profitable minerals, by the repeal (that has been made since our appendix was written) of a discouraging act of parliament made in the reign of *Henry IV.* And though our hydrostatical way of estimating fossils will not determine how rich or poor they are in this or that particular metal; yet (as is intimated at the beginning in the ensuing paper) it may, on many occasions, serve to keep those that are venturous, and not skilful, from being deluded by cheats, or from deluding themselves with ill-grounded expectations, which the promising appearances of divers fossils, especially *marchasites*, will temptingly invite, but never answer.

S E C T. I.

S I R,

A way
proposed
for the
previous
examen
of ores.

AT a time wherein so many ingenious or industrious men appear very solicitous to discover and to work mines, both here and in *New England*, and others of his majesty's *American* colonies; it will not probably be thought unseasonable, nor prove unwelcome to the seekers of subterranean treasures, if my desire to do them a piece of service, make me borrow of a paper, I long since wrote about some things relating to the *Materia Medica*, a few paragraphs that contain a way of exploration of minerals; which, though it reaches but to one of their qualities, will perhaps, by reason of the considerableness of this, keep, on certain occasion, some searchers after mines from beginning chargeable works, or prosecuting them with too great expectations, which are usually followed by proportionable disappointments. And I make the less scruple to suffer this fragment to leave its company, and present itself to you; because after the misfortune, I have formerly signified to you of the loss and spoiling of several of my writings, I know not when, if ever, I may have opportunity of communicating to my friends the treatise that these paragraphs belong to.

THAT part of the forementioned treatise that concerns my present purpose, is founded on an experiment, whereof what you are about to read is one of the applications.

I SHALL then succinctly inform you, that the observation, whereon my discourse was grounded, is double, as will by and by appear; and that the rise of it, which will help to understand the nature and influences of it, was this. I thought fit (for reasons elsewhere given) to find out what was the specific gravity of a pure stone, such as I supposed crystal, or white marble, or a stony icicle, to be; and found it by the hydrostatical way of trial, (doubtless not unknown to you) that is delivered in the essay called *Medicina Hydrostatica*, whereof, when you please, you may command a sight, to have to clear common water, equal to it in bulk or magnitude, pretty near the ratio, or proportion of two and an half to one; or, which is somewhat more obvious to conceive, as five to two. I said pretty near, because it is not always exact, nor need be for our present purpose, but usually enough does somewhat rather exceed that proportion than fall short of it; but that is so little, that it may, on all common occasions, be safely enough neglected by a mineralist: though, if one pleases, one may make use of the proportion of $2\frac{3}{4}$ to 1, that is, of 11 to 4.

S E C T.

S E C T. II.

THE uses that may be made to our present purpose of this fundamental observation, are either of a more general or of a more particular nature.

As to the first of these, when my intention is only to discover in general, whether a fossil propounded, or perhaps casually lighted on, may with probability be judged to contain any substance, either metalline, or belonging to some fossil of affinity to a metalline nature; and also, whether in case the first question be resolved in the affirmative, the proposed body does, indefinitely speaking, contain much, or but little, of the metalline or other adventitious substance: when, I say, I would only make those general inquiries, I weigh the body I would examine, first in air, and then in water, and observe the proportion in specific gravity between them; and if I find it weigh either less, or but little more, than crystal or marble of the same bulk, I judge it unlikely to contain any metalline portion, considerable for its quantity. And if it weigh manifestly, or somewhat considerably more than marble or crystal, I guess, that in proportion to that excess, it abounds, more or less, with a metalline ingredient, or one or other of affinity to a metalline nature.

To explain myself a little by two or three examples; it is known, that the magnet is vulgarly reckoned among stones, and its great hardness confirms men in that opinion. But having observed, that loadstones, especially those that come from some places, that I elsewhere take notice of, seem to be apparently more ponderous than common stones of the like bulk; we weighed them in air and water, and found their specific gravity, especially of some of them, so far to exceed that of crystal or marble, that it could not be difficult for us to conclude, that these fossils contained a not inconsiderable proportion of metalline matter, which, by collateral experiments, delivered in another paper *, appeared to be of a martial or ferruginous nature.

EMERI is a fossil well known to many tradesmen, especially armourers and gunsmiths, by whom it is commonly reputed a mere stone. But finding that its weight in water considerably exceeded that of crystal of the same bulk, since it was to that liquor very near as 4 to 1; I conjectured, that it contained a metalline substance, as afterwards by proper trials I found it to do. Upon the same ground (its weight in my hand) I concluded, that lapis hæmatites, that is commonly sold in shops, and, as its name witnesseth, passes for a stone, did not sparingly participate of a metalline ingredient; in prosecution of which conjecture, I quickly thought on ways whereby I discovered, that iron or steel was the metal it contained.

AND not to accumulate instances in this place, I shall advertise you in general, (what perhaps may hereafter be found useful to several enquirers) that, upon the grounds hitherto mentioned, I was invited to guess, that divers bodies, that were little suspected to be of a metalline or mineral nature, did really contain a portion of substance that was so. And I remember in particular, that having met with granates of several sizes, that were not *Bobemian*, but were found in other parts of *Europe*, and some that I discovered in a kind of talc, that was brought me from *America*; which angularly figured stones, I suspected by their weight to be metallic, and found, by hydrostatics, to have a specific gravity considerably surpassing that of crystal. Upon these grounds, I say, I supposed them to participate, and that not very sparingly, of a metal, one or more; and, by other ways of exploring, found that I had guessed aright; since I was able, notwithstanding the great compactness of such seemingly

* The author means a paper containing experiments and observations about the loadstone, as it is a mineral.

vitreous bodies, to discover there a decomposition, and extract thence a metallic substance.

To these I might add other fossils, and some that were not, even by men not unskilful, suspected to have any metallic ingredients. But I have not time to speak of them, and therefore shall proceed in the lately begun discourse.

S E C T. III.

TO illustrate then the general observation formerly laid down, and make it more distinct, I shall subjoin the following remarks.

FIRST, I do not pretend by this way to make any more than probable conjectures and estimates about the contents of the bodies, I examine by it. But though the estimates grounded on it be not always true, yet they may be frequently useful, as may be gathered from some of the subsequent observations.

SECONDLY, if the fossil proposed be lighter, especially if it be much lighter, than so much crystal, it is an almost certain token, that it is not a metalline ore. And this negative use, if I may so call it, of our hydrostatics, may be more safely relied on, than the affirmative consequences usually can be. Thus when I find that jet, though a fossil dug up in veins, especially in the *Pyrenean* mountains, (as a learned man, whose brother has there a mine of jet, assured me) has far less of specific gravity than crystal, I conclude it to be no metalline body. The like inference I make on the same ground, as to fossil amber or succinum, sulphur vive, and the observation holds in common sulphur, (clear or semidiaphanous) English talc, Venetian talc, and some other firm concretions, whether brittle or not, that are dug out of the earth. Among these, I think fit to mention particularly black lead, lest the name it bears should deceive men into a belief, that it is an ore of that metal. For having found its weight, in reference to water, to be but as $1\frac{86}{100}$ to 1. And gathering from the smallness of its specific gravity, that it would prove to be very unlike our true common lead ores, I found, upon trial purposely made, that it was a mineral *sui generis*, and seemed, upon the score of more than one quality, to be of kin to a sort of talc that I have met with.

THIRDLY, we should distinguish between the several uses that fossils may be sought for and examined by men of different professions, or designs. And therefore, if a fossil be found to be somewhat, and yet but very little, heavier in specie than crystal or marble, it may possibly have a metalline or mineral portion, which, though very small in quantity, may consist of such efficacious parts, as may make it deserve the esteem of a jeweller, a physician, or a chemist. But if the surplus of specific gravity be inconsiderable, the fossil itself will be so too to a mineralist, that seeks not to gratify his curiosity, or make a good medicine, but to fill his purse. For the charge and trouble of working a fossil, so poor in metalline substance, will probably either exceed the profit, or keep it from being considerable; whereas if the specific gravity do much exceed that of marble or crystal, it may give good hopes of proving a subject profitable to be wrought on.

FOURTHLY, but here I must give notice, that though, for the most part, the great ponderosity of a fossil proceeds from a portion of some metalline substance, more strictly so called, that is embodied with the other part of the concrete; yet this alone is indeed a certain sign, that the fossil is not a meer stone, but is not alone a sure sign, that the mineral portion is properly metalline; and therefore, where there is just cause of doubt, it is best to endeavour by some collateral signs to resolve it. The reason, why I thought fit to give you this admonition, is, that, besides metal-

lines

line ores more properly so called, there are other fossils, which some call semi-metals, others *media mineralia*, and others again give other appellations to; which fossils, though of affinity to metals, are wont to be distinguished from true metalline ores; such (fossils) as are (that I may here name the principal of them) antimony, bismuth (usually in our shops called tin-glass), *lapis calaminaris*, and pyrites (commonly called marcasites, and vulgarly, in English, vitriol stones). But there will not perhaps occur many cases, wherein it will be necessary to have recourse to collateral signs, to discern whether the mineral portion of a fossil be, in a stricter sense, of a metalline nature, or not: for these semi-metals, that I speak of, are most commonly found either in veins, or in masses, or great lumps of their respective kinds; and easily discover, to one that considers them with so much as a moderate measure of attention and skill, what species of fossils they belong to. I have indeed from *Devonshire* received a lump of matter, which the owner of the mine, not knowing what to make of, desired my opinion of, wherein I found some antimony mixt with lead, which was the predominant body. But such mixtures occur not often enough, at least here in *England*, to keep our way of estimating ponderous fossils from being, on most occasions, useful.

S E C T. IV.

FIFTHLY, it will be almost necessary to give you notice in this place, that there may be a two-fold estimate made of the specific gravity of ores; one, when the metalline body proposed is weighed in its natural state, that is, as it is taken out of the earth, accompanied with the spar, or other heterogeneous matter, that firmly adheres to it, (only the loose earth being first washed off:) and the other, after it has been beaten small and separated from stony and other heterogeneous substances, by the help of water; where being skilfully agitated, there is easily discovered a notable disparity in weight between these and the genuine or metalline parts of the ore, which, being thus severed from the rest, are called, for instance, washed tin, if afforded by a vein of that metal. And sometimes also it is very useful, if not necessary, to prepare the ore by roasting it (as they speak) once, or oftner, or by keeping it several hours in a competently strong fire, as is usually enough done to prepare copper ore, especially if it be stubborn. I have distinctly mentioned these two states, wherein the weight of an ore may be estimated; because I have observed, that in several cases it will much import the experimenter to distinguish them carefully. For several ores (which, in their natural state, have too little of specific gravity to make them judged worth the charge of being wrought) may yet, being prepared by water and fire, afford a metalline portion so heavy in specie, that it may give fair hopes of containing in it some portion of silver, or of gold; and in that case a small proportion of the former, and a much smaller of the latter, would render the ore considerable, and make it pretty rich, though not in reference to the quantity it yields of the predominant metal, as lead, tin, or copper; yet in a more absolute sense, as it may better recompence the charges of him that shall work it. Which brings into my mind, that some time ago a piece of lead ore, then brought out of *Ireland*, being offered me to judge of, I found it so light in the lump, that I thought it not at all worthy to be wrought for lead; but afterwards upon trial it appeared to be, though very poor in that metal, yet so well stored with corpuscles of silver, that I scrupled not to encourage the owner to bestow pains and cost upon it.

S E C T. V.

BUT there is one kind of minerals, that I have observed to impose on men so often, that I think it necessary to take a particular notice of them in this place. For, not to mention examples, that I might draw out of the books of travellers and navigators, I have met with, I know not how many, that have built great hopes, and some (which is worse) that have been at charges upon those illusory expectations of great matters from marcasites. And, I remember, I have had sent me, or brought me, not only from places nearer home, but from hotter and colder countries of the *Indies* themselves, fossils, whereof I was earnestly desired to give my opinion, that I found to be but marcasites: and many of these fossils having two qualities, that make them very fit to delude the vulgar and the unskilful, namely, first a multitude of shining streaks, or other glistering parts, usually of a colour near enough to that of gold, and sometimes to that of silver; and then, a ponderousness usually not inferior, at least, to that of true metalline ores; marcasites, I say, being thus fitted to delude the unskilful, I have had much ado to undeceive some, that brought or sent me them from *America*, of the pleasing confidence they had entertained, that these promising fossils were lumps of rich ore of gold, or silver. Wherefore since their ponderousness (which is the criterion of minerals I am now treating of) is one of the two chief things that delude so many, I think it expedient to subjoin some few but various instances of the specific gravity of marcasites, whereby it may appear, that some of them are, bulk for bulk, far more ponderous than divers true metalline ores, that I have tried, have been found to be. And indeed this great ponderosity has several times invited me, before I made any artificial trial of propounded fossils, and sometimes before I took them out of the bags or papers to look on them, to judge, tho' perhaps to the surprize of those that brought them, that they were not true ores, but marcasites. And, because this mistake is speciously grounded, and has deceived many, whereof some have undertaken voyages betwixt *Europe* and the *Indies*, upon confidence of the value of these glistering stones; I shall decline a little the method of this paper, which confines me to the hydrostatical way of exploring minerals, to advertise those whom it may concern, that they may easily try almost any stone, that by its great weight and lustre they suspect to be a marcasite, if they put it either within a crucible or without one, into a well kindled fire, and blow now and then upon it with a pair of bellows. For by this means the sulphur, wherewith marcasites are wont to abound, (so that I remember, that, even by distillation in a close vessel, I had 3iv. of good brimstone, like the vulgar, out of lbij. of the stones) will take fire, and burn with a flame for the most part blue like that of common sulphur. And if, when it ceases to flame and smoke, you take it out of the fire and let it cool, you will find it deprived of all the gaudy appearance of rich metal it had before, and turned to a brittle blackish substance, differing enough from that of a metalline ore, more strictly so called. These last words I add, because, in a lax sense, it is easy to shew, that marcasites, at least those that I have tried, may be looked upon as a kind of metalline bodies. For, besides that I have found divers of them to contain particles of copper, I found all (that I purposely examined) to contain, and some of them plentifully enough, corpuscles of iron or steel, as plainly appeared, when, after the newly mentioned calcination (for with crude marcasites I found not the following trial to succeed) I applied to the pulverised remains a vigorous load-stone; to which great multitudes of martial corpuscles quickly adhered. And, I remember, I found in a catalogue of the fossils of *Misnia*, published by the experienced *Kentmannus*,

mannus, that, under the head or title of pyrites, he brings in several marcasites, whereof some contained copper, others silver, others gold, and others both the last named metals; which brings into my mind, that having presented, among other English minerals, a curiously shaped and very fine marcasite, to a virtuoso, that is now overseer of one of the emperor's best mines; he quickly examined it by a peculiar way not known to me, hoping to find in it some gold or silver; but, instead of that, obtained a portion of running mercury, which he was pleased to present me, and which I presume I may have yet by me.

THOUGH I thought it needful to give the foregoing caution about marcasites, for the reasons before expressed, yet my design is only to keep the less skilful from being deluded by their promising appearance. For otherwise I do not deny, but that it is possible for a skilful artist to make (at least of some sorts) of them a gainful use, either by fixing the volatile gold or silver, that may be found in some of them; or by graduating silver by their means; or perhaps by some other ways that I can but guess at. But (to add that on this occasion) that, for which I much more value marcasites, is, that (NB) somewhat more than bare conjectures make me think, that being dexterously handled, and perhaps even without additions, they may afford very noble as well as uncommon medicines, and particularly in continual fevers, though their operation be usually scarce sensible, but by their good effects.

S E C T. VI.

ON this occasion I must not forbear to give an advertisement, that may be of good use to divers examiners of ores, especially such as are novices in the art of reducing them. And it is this, that as to many who make trials of ores, though they much value their own flux-powders, or those that are cried up by others, yet they commonly act as if they expected nothing from those that they prefer, but that they should more than others facilitate the fusion of the ores; as that which being once done, the metalline part will be separated by its own weight, or as it were spontaneously. But yet, having purposely examined the matter more nicely, and compared the quantities of metal that we obtained from two portions of equal weight of the same ore, we found that those proportions did very considerably differ, though that which yielded least metal was fluxed down with a fondant (as the French compendiously call what our men, after the Germans, call a flux-powder) that is dear enough, and not undeservedly esteemed, when such ores are to be handled. And I little doubt, but that, from other metalline ores, a greater portion of pure metal may be obtained by some, but little employed or known, fondants, and perhaps cheap ones too, than by others that are much more in use and famous; of which I may elsewhere give some instances: now one, that first occurs to my memory, was afforded me, by two equally heavy portions of the same lead ore devoid of spar; whereof one, being reduced with a due weight of nitre and tartar fulminated together, afforded much less of malleable lead, than was obtained by means of half or a quarter of the quantity of filings of *Mars*, which, for trial's sake, I then employed on the other; to shew, how much better a reductive of that kind of ore that metalline flux was, than even a sharp and fiery fixed salt.

AND yet (to give you an instance in a much more precious mineral than lead ore) I shall add, that having, for curiosity's sake, tried some ounces of good native cinnabar finely pulverised, one half with a fixed alcali of tartar, and the other with a different flux-powder, we obtained from the first parcel twice as much mercury

as we did from the other half, distilled with another fixed alcali, even though it were of a mineral nature.

S E C T. VII.

Some Observations about Native Gold.

About the hydrostatical examination of gold and its ore.

GOLD being by far the most noble and precious of metals, it may be ill taken, if I should here leave the ore and mineral, that affords it, altogether unmentioned; and therefore, though I have but two or three observations, pertinent to my present subject, to offer about it, yet I think it may not be useless to say somewhat of that ore in this place.

I KNOW there are many learned men, and even chemists, that think there are no such things as gold mines, properly so called. And I confess, that I myself was long kept from being confident of the affirmative. And I was induced to this diffidence by considering, that though, having had the honour for divers years to be a member of his majesty's council for foreign plantations, I had the opportunity to converse with a considerable number of navigators, and other great travellers, and with divers persons that had settled themselves in the *Indies*, I made it more than once my business to enquire, not whether they knew of any golden mines in the popular sense of the word, for I knew that there are in *Hungary*, *Macedonia*, and some other countries, mines that afford gold enough to deserve to be wrought for it; but whether there are any real mines, or veins, whereof gold is manifestly the predominant metal. Having, I say, proposed to many this question, I was answered, that some of them indeed had heard of such mines, but none of them had ever seen any. But afterwards I saw some ore that I judged true, that was presented to his majesty *Charles II.* and I also received from an unknown virtuoso, residing in the *East-Indies*, together with a very civil letter (which I wished had been more historical and less complimentary) among other less valuable pieces of ore, one in whose clefts, and a little beyond them, there appear some lumps, wherein by their colour, and other signs, it is so apparent, that gold is the predominant metal, that I little doubt, but that, if I would spoil the lump by breaking the spar, I should find these metalline protuberances malleable, without the help of the fire.

BUT being unwilling to destroy the entireness of it, I shall make only a few and short remarks about this ore.

THE biggest piece, and that which was best furnished with metalline parts, being about an ounce and a quarter in weight, contained so great a proportion of spar, in reference to the metal, that its weight to an equal bulk of water was but as $2\frac{9}{10}$ to 1.

BUT somewhat to compensate this smallness of the metalline portion, that, that was of it, seemed to be all gold, there being no sign of any other metal in that lump of ore, nor in some lesser ones that I received with it.

THE spar (as our mine-men used to call that stony matter in which the true ore is immediately lodged) did not look like the spar of lead ore, or that of any other of our English metals that I have seen, but seemed at first view to be a kind of white marble with a dash of yellow.

AND, upon trial, I found it to differ more from the spar of lead ore, which, with us, is usually white, and almost semidiaphanous, than in the colour. For, whereas our spar of lead ore is oftentimes so soft or tender, that it may easily enough be cut with a knife, we found the sparry portion of our gold ore to be a solid stone, and that so hard, that being struck with a piece of steel, it would yield sparks of fire.

WHEREAS also I found, that the spar of lead ore would be easily enough, and in a short time (as about a quarter of an hour) calcined to a kind of lime; our golden spar, though kept some hours red hot in a crucible, did not appear to be at all calcined. And whereas I had formerly observed, that I could easily dissolve the spar of lead ore in some acid menstrooms, and even in distilled vinegar itself, I did not find, that our golden spar, though kept divers hours in stronger menstrooms, as spirit of salt, aqua fortis, and aqua regis, was dissolved or manifestly wrought upon by any of them, as if it were of a glassy nature, as well as of a very hard one.

A PIECE of spar, that had scarce any gold at all that could be discerned, being hydrostatically examined, was in specific gravity to water as $2\frac{6}{10}$ to 1. which ponderosity does but very little exceed that of white marble, or that of some good spar of lead ore that was compared with it.

IF I had received a greater quantity of gold ore, I should have given a less imperfect account of this subject. But these notes, such as they are, may perchance not be unwelcome to some of those many English and other searchers for mines, that have never seen true gold ore, or have not had liberty to make any trials upon it, and yet are in search of gold mines, especially in *Jamaica*, where, if I much misremember not, the *inquisitive gentleman that conquered it for the English, told me, * General Venables. at his return thence, that the Spanish governor of the island, when his prisoner, confessed to him, that there was mineral gold, though the Spaniards did not dig deep for it for want of workmen.

S E C T. VIII.

BUT by the mention I have made of the true ore of gold, I would not discourage any from seeking for that rich metal in the veins of some other metals; because, in divers of these, I know it may sometimes be found blended with predominant minerals. This may appear by those Hungarian copper mines of *Cremnitz*, whence a considerable quantity of gold is yearly obtained. I have elsewhere also taken notice, that I have seen an English tin ore, part of which I presented to the king, wherein there lay, in little cells, a good number of small leaves or chips of gold, which I saw there with pleasure. And though the tin-men, not being able to separate them with profit, usually melted both the metals together, and sold the product for mere tin; yet an experienced gentleman, who was owner of the mine, assured me, that one of his workmen, who had many little children, employed them with good profit, to pick the gold with their small fingers out of the skilfully broken ore. And though lead mines be looked upon as those, which the matter whereof gold is made is seldomeft found to be near, and does as it were avoid; yet there is a place in *Scotland*, (whose name I remember not) where over a lead mine, upon or near the surface of the ground, they oftentimes find grains or bigger pieces of native gold without spar; some of which, by the ingenious owner's favour, I was master of, and thought sometimes worthy of being presented to that curious examiner of ores, his highness prince *Rupert*. And still I have one bit of native metal by me, which, if much I mistake not, I had from the same place: which fossil, though I found it hydrostatically (because being native I would not melt it) not to be, as the owner supposed, pure gold; yet gold is the predominant metal in it, and the piece weighs forty odd grains.

SINCE I wrote the last foregoing lines, I have, in an old collection of my notes, found three, whereof the first is thus set down, a grain of *Scotch* gold, such as nature had made it, without any adhering stone or spar, weighed ziiij. + 21 grains:

the second thus, another grain of the same gold, that had here and there some little stone or spar sticking to it, and partly inclosed in it, weighed $\text{ziii.} + 3$ grains; so that the heterogeneous substance being, according to my estimate, abated, it weighed about ziii. : and the third is subjoined in these terms, a grain of *Scotch* gold weighed in air 43 grains, in water $39 \frac{1}{2}$ grains, differ. $3 + \frac{1}{2}$ propor. $12 \frac{2}{3}$ to 1.

THIS lightness of a yellow metal (heavier than brass or silver) deserves a reflection; but I cannot stay to make it.

It several times happens, that among the lesser grains of gold, that are more properly called sand-gold, there are found pieces, some of which I have seen, that are singly big enough to be tied about with an horse-hair, and so weighed in water, as lumps of ore of other metals are wont to be. And to such bigger fragments of gold, it is manifest, by what has been already delivered, that our hydrostatical way of exploring may be usefully applied. For since, according to the famous and diligent *Merfennus*, and some esteemed writers, pure gold is to water of the same bulk, as (about) 18 to 1; and by my examen of very fine gold, I found that it equals about nineteen times the weight of as much water (I say about, because I unhappily lost the exactest of my trials upon gold among those made upon the other metals in a most exquisite balance) as is equal to it in bulk; it will readily appear, whether the fragment proposed be perfectly pure or not. For if its weight amount to near nineteen times as much water in quantity, we may conclude it to be unalloyed; and as it wants less or more of this ponderosity, we may conclude it to be more or less pure.

S E C T. IX.

IT is known, that since we began effectually to cultivate the African trade, it frequently brings into these parts, besides things of less value, considerable quantities of what, from the most usual size of it, is by many called sand-gold; but which, by reason of the very unequal bulks of the grains, may perhaps justly be called fragments of gold; since being brought from the maritime parts, where no mines of gold are yet found, they seem to have been broken off and washed away from hidden veins by the violence of waters, that having carried them as far as they were able, left them a prey to men. Now (because that unless it be perhaps brought by, or for some virtuoso) there is scarce any gold that comes into *Europe* in lumps, under the form of ore; but a great deal that is brought from *Guinea*, (and those other parts of *Afric*, which for that reason are comprised under the name of the golden coast) in the form chiefly of sand or gravel, grosser or smaller, and partly also of less minute pieces; it may conduce to the scope of these papers to take notice, that in making estimates of the genuineness and the degrees of purity of these native fragments of gold, our hydrostatical way of exploring may be of no small use.

For first, when we have once discovered the proportion between pure or exquisitely refined gold, and water equal to it in bulk, (which proportion I have lately given exactly enough for our present purpose) it is easy, by our hydrostatical method, to examine the fineness of any other gold proposed; so at least as to know, whether it be perfectly fine; and if it be not, whether it do considerably fall short of perfect fineness. But since of this I elsewhere treat, I think it more proper to observe in this place, that when once a man has found the true specific gravity of a parcel of sand-gold, (smaller or coarser) whose degree of fineness he knows by collateral trials, or some other means, (whatever they be) he may (as was formerly noted when I spoke of metalline ores) take this specific gravity for a standard, with relation

relation to which he may make his estimates of the fineness of other parcels of the like native gold, that he is concerned to buy or to examine. And, by this means, he may oftentimes prevent that chief fraud of the negroes, whereof several traders to the golden coast are not a little apprehensive, as being in danger to be much damaged by it. For they complain, that though the blacks be, otherwise, for the most part, but a dull sort of people; yet they have often made a shift to cheat the traders, by clandestinely mixing with the right sand-gold, filings of copper, or rather of brass, whose colour does so resemble that of gold, that the fraud is not easily discerned. And in the account of a late voyage, made by the French to the coast of *Afric*, to trade especially for gold, it is acknowledged, that the officers were egregiously cheated by the blacks, who, instead of paying them for the wares they brought with powder of true gold, gave them powder of brass, or gilt copper, which those that were not accustomed to make trial of such wares, are, as the relater complains, in a scarce evitable danger to be cheated, as these Frenchmen confess they were in one day to the worth of a thousand crowns. But in regard that, as trial has informed me, brass is not quite half so heavy as fine gold of the same bulk, if there be any considerable quantity of filings of brass with the gold; this mixture being put into such an hydrostatical bucket, or wide mouthed glass, as is mentioned in the essay, will manifestly weigh less in water, than if it were all gold. And by comparing its specific gravity, with that formerly found to the grain gold pitched upon for a standard, the greater or lesser decrement of the suspected gold will help to make an estimate of the quantity of brass, mingled with the natural gold.

S E C T. X.

BUT though my present undertaking do not oblige me to consider sand-gold, otherwise than hydrostatically; and though it highly concerns merchants and others, that deal in so rich a commodity as gold, and that is by so many studiously adulterated, to be furnished with nice and trusty balances; yet, because divers persons, especially seamen, that trade to the gold coast and other parts, where sand-gold is to be met with, do, (perhaps too often) without being furnished with good scales and sufficient skill to use them, venture upon buying such precious wares; it will not be to depart from my general and main design, which is to serve the public, if I deviate a little from my subject, and add to the hydrostatical way, lately proposed, of examining sand-gold, two or three chemical ways to the same purpose. First then, if he that would purchase sand-gold, doubts that there are filings of brass (or of copper) mixed with it; in case he have aqua fortis at hand, he may quickly discover the cheat, if there be any. For it is known to chemists, that aqua fortis will not work upon gold, and therefore if there be filings of brass mixed with it, the operation of the menstruum upon those, together with the colour betwixt blue and green, it will thereby acquire, will discover the deceit. But, because if nature hath mingled much silver with the gold, the proof by aqua fortis will require skill, and may puzzle those that want it; I shall add, that good spirit of urine may be substituted in its stead. For I elsewhere shew, that it will readily work upon filings of copper or brass in the gold, and gain from them a fine blue colour; and this being a menstruum not corrosive, like the other, but harmless to most bodies, and a good medicine for human bodies in several diseases, (as the jaundice, pleurisy, some kind of fevers, coughs, and asthma) may be fit to be carried about in voyages, and to be preferred to aqua fortis. And to make the operation of this liquor on filings of brass far more quick, than if the solution be attempted

an ordinary way, I thought upon the following expedient. I took filings of brass, (and the like may be done with those of copper) amounting to the weight but of eight or ten grains, or perhaps less; and having with my finger spread them somewhat thin upon a small piece of white paper, I moistned them thoroughly with good spirit of fermented (or putrified) urine, (which will not dissolve gold) that by this means the air might promote the dissolutive action of the menstruum; which accordingly it did so well, that, to the surprise of the beholders, there appeared in less than a quarter of an hour, and sometimes in a few minutes, a manifest, if not also a deep and pleasant blue colour upon the paper, or on some of the filings, or both. Those that carry with them spirit of hartshorn, or such other volatile alcalies for medicinal uses, (as some modern ship-chirurgeons do) may, for a need, employ that instead of spirit of urine. Nay, one may for the same purpose make use of urine itself never distilled, if it be stale and rank enough, (as it grows to be, sooner in hot airs than in others :) since having for trial's sake moistened with such urine some filings of brass, thinly spread on a piece of paper, there was a manifest blueness produced in about a quarter of an hour. But I thought also of another way, which I presumed would be better liked by most traders, as more commodious; because the agent being in a dry form, cannot, like spirituous liquors, be spilt; and though it be more easily procured, may serve the turn almost as well. This agent is common sal armoniac, of which, when I have occasion to use it, I reduce a greater quantity to powder, than I guess the quantity of water, I shall need, will dissolve; that the liquor may be satiated with the salt. With this brine I thoroughly wet filings of brass, (or copper) after the forementioned manner, thinly spreading them with my finger on a piece of paper, or some other fit and flat body; and in a short time (as about a quarter of an hour or less) there will appear a greenish blue colour, drawn from the brass by the liquor: which (liquor,) I suppose, I need not tell you, will not work on the gold, wherewith the brass is mingled.

S E C T. XI.

I HAVE observed such a variety of appearances and disguises of metalline bodies, and some other minerals, that I would advise those that are given to the search of mines, and other fossils, to have their eyes always open when they pass (especially by land) from one place to another, that they may be ready to take notice of any unknown or uncommon fossil, that they chance to see in their way; and that having taken it up, they do not neglect to poise it in their hands, (which after a little practice it will not be difficult to do, though not exactly, yet not unusefully) and if they judge it to exceed the weight of crystal, or marble, to examine it hydrostatically at their first conveniency. For there are in *England*, as well as in divers other countries, useful fossils, that are wont to be overlooked by the unskilful; and I have found in this kingdom, even upon, or very near the highways, eagle-stones, and some other minerals that were not suspected to be of English growth. And I remember, that having occasion, in the country, to pass by the work-house of an ingenious potter, that I sometimes employed in his profession; and having viewed the ground somewhat attentively, among some other uncommon fossils that I took notice of, I made a discovery of manganese, or magnesia, whereof I gave the potter an advertisement, which he afterwards thankfully made use of, having found the mineral very proper for the glazing and colouring of his vessels.

NOR was this the only kindness, that skill in mineralogy, as little as mine was, enabled me then to do him. For he having invited me to view very privately, a
place

place wherein there was great store of a fossil substance, that men knew not what to make of, because they had not seen nor heard of the like in *England*: the knowledge I had of some Italian mines, made me quickly guess what it was that was taken for an unknown metal. For it is true, that this mineral was not divided into lumps of such shapes and bignesses, as make glittering fossils pass for stones among the unskilful, such as are the marchasites, whereof they make vitriol, and are found by the sea shore in or near the *Isle of Wight*, and (though not so plentifully) in other parts of *England* (where I have found them) but ran a great way (and I had not time or liberty to try how far) under ground, like a vein of metalline ore. But this notwithstanding, I judged the mineral to be but a marchasite, in a form unusual indeed in *England*, but which is not without resemblers in some parts of *Italy*; which conjecture I found true the same day, by some easy trials that manifested it to abound much more in vitriolate salt, than any marchasite that I had examined in the form of stones. So that, though I had no opportunity to try, whether or no it contained any better metal than iron; yet I concluded, that, *ceteris paribus*, it might be employed to make store of vitriol, in far less time, and with far less cost, than the marchasites made use of in the vitriol works at *Deptford*, or elsewhere in *England*.

I REMEMBER also, that a mineral of an odd, though pretty appearance, being sent me, whose species was unknown to the mine-men that dug it up, I guessed that it was a fossil, that I had not found in a good printed catalogue of our English minerals, namely, the ore of Bismuth. And in this conjecture some trials, purposely made of that mineral, sufficiently confirmed me, and gave me cause to be sorry, that the vein, that afforded it, was so very small, as the diggers found it, of an ore, that has properties enough; and is by some famous chemists affirmed to have some, that are not only rare, but wonderful.

BUT the chief thing, that invites me to recommend in this place, to those that travel, an heedful eye on the ore-like, or ponderous substances, that may occur to them, is, that one of the applications of our general remark about the specific gravity of fossils may be extended to an use, that has not, that I know of, been made by mineralists, and which yet I thought fit not to overlook: because I see no need we should be confined to examine only those fossils, whereof we can obtain parcels big enough to be weighed in water in the entire body. For besides other minerals, that may be found profitable to the physician, the drugster, or the mineralist, the ores, or wombs of metal themselves, may be divers times found disguised in the form of earth, or of mud, easy to be dried: which fossils, though (because they chance not to be found in lumps) unfit to be kept immediately suspended by an horse-hair, may be conveniently enough examined by the help of a glass-jar, whose weights in air, and water, and their difference, (which gives the specific weight of the vessel) have been taken once for all, which I usually call an hydrostatical bucket. For this vessel being almost filled with the propounded fossil, and carefully counterpoised in the air, and then thoroughly wetted with water, and when it is so, warily let down into the water, and kept suspended by an horse-hair to a tender balance; when these things, I say, are done, the difference between the weight of the mineral and vessel, when they are under water, and their former weight being observed; and the specific weight already found of the vessel itself in water being subtracted from that difference, there will remain the weight of the fossil only, (which we here suppose to be heavier in specie than water, and not to be dissoluble in it) or the mineral itself in that liquor; and consequently the proportion between that body, and water of the same bulk, as is elsewhere sufficiently declared.

S E C T. XII.

TO manifest, that this expedient may be of use in divers cases, I shall only here observe, that a late author, who hath published an account of *Swedeland*, declares, that one of the best sorts of Swedish iron (which, you know, is much esteemed in its kind) is divers times found in the form of a red mud, at the bottom of lakes, or far lesser stagnant waters; which I the more readily believe, because I have found some English okers (that pass but for red earth, or stone of that colour) to be richer in iron than I found some famous ores of that metal to be. And another experienced writer, who gives us an account of the gold and silver mines of *America*, among which he spent several years, takes notice, that gold itself is found, from time to time, disguised into a reddish earth, or is (though unsuspectedly) harboured in it. An Italian mineralist, of repute in the last age, doth also take notice, that a reddish sort of earth doth sometimes contain a portion of the richest metals. I have observed some European diamonds, as many call a sort of clear and finely figured crystals, to grow in a red earth, whence I have taken up pretty store of them. And an inquisitive traveller, who has been in the *Indies*, presented me with a certain earth, which he affirmed to be from the diamond mines, (I presume in the kingdom of *Colchonda*) which I found to be also red, and which I made some trials of, that belong not to this place.

Vanno-
chio.

S E C T. XIII.

BUT the profitablest use, that a mineralist may make of our hydrostatical bucket, is to employ it much in weighing variety of coloured sands and gravels, particularly some hereafter to be mentioned.

AND to let you see, by an easy instance, how apt we are to overlook sands for want of trying them by weight, I shall not tell you, that I have sometimes seen a sort of sand, that was slighted as common or worthless, which being washed and viewed in a microscope, though none of the best, looked like an aggregate of small granates, and perhaps was so; but shall here content myself to instance in that black sand, that is commonly used in *London* and elsewhere, only to dry up the ink of words, that have been newly written. For having observed, when I had some quantity of this in my hand, that it was manifestly heavier than common sand, I thought it worth the being examined by the hydrostatical bucket; by which trial, that which we employed appeared to be to water of the same bulk, near about as $4\frac{6}{10}$ to 1. And having, for reasons, that I cannot stay to mention, judged this sand to be a mineral of a martial nature, I was confirmed in my conjecture, by melting it down with two or three parts of antimony, and casting it into an iron cone. But I was more than confirmed in the same conjecture, when having tried it with a vigorous loadstone, I found it to be far richer in metal than any of the English iron ores I had made trial of, and (except perhaps one) than any of the outlandish: for having taken, at adventures, some drachms out of a much larger quantity, and weighed it, I found, that at least seven parts of eight would easily be taken up by the magnet. But such observations as these are not the things, that chiefly move me to recommend the examen of sands and gravels to the mineralist; particularly those sorts of them, that being somewhat ponderous, are reddish or yellow, especially if they retain those colours, after they have been made red hot, and quenched in cold water.

BUT therefore to proceed to the mention of richer sands, it is known, that from the coast of *Guinea*, European traders, of several nations, do yearly bring gold to a great value

value, which is washed or picked out of the sand. And even in *Europe* there are rivers, whose sand is enriched by grains of gold, for which the *Tagus*, that runs by *Lisbon*, and *Paëtolus*, were famous among the ancients. I knew an industrious chemist, who owned to me, that he got gold with profit from the sand, which he found in some places of the banks of the Rhine: and there is a little river in *Savoy* proceeding from the mountains there, on whose banks, after a land-flood, I saw poor people busy themselves in seeking for grains of gold. Some trial (also) that I caused purposely to be made, confirmed me in a conjecture, which possibly may hereafter prove beneficial to many, namely, that the sands of divers places, if they be skilfully treated by a dextrous chemist, may afford much more gold than is picked or washed out of them in form of grains. For besides, that there may be many atoms, or corpuscles of gold, that are so very minute, and stick so close to grains of sand, that they are neither taken notice of by the eye, nor separable by washing and picking; besides this, I say, there may, as I conceive, be many particles of gold incorporated with the body of the sand, which may be a kind of womb for matter of a golden nature, that a skilful artist, by the help of proper additaments, may separate with profit, especially if, with litharge or minium, he first reduce the sand to a glass, and then take care to get the volatile gold, by giving it a pure body fit to retain and fix it, such as is fine silver: out of which, I remember, we separated by quartation, (though without profit, because of the charges, and of the small quantity we could work with at once) from as much vitrified sand, and two or three fluxing additaments of small price, as were contained in one crucible, (that broke too before the operation was near done) sixteen grains of pure gold, that you may yet see, if you desire it.

S E C T. XIV.

IT need not startle you, that in reciting this experiment, I made mention of volatile gold. For though I know, that divers learned men, and some able chemists themselves, look upon it as a fictitious thing, and that seems to bear a kind of contradiction in its very name, in regard of the perfect fixity they presume to be an essential property of gold; yet I do not scruple to dissent from them, being warranted so to do by my own experience. For I have more than once made use of a way, wherein, by the help of an additament, inconsiderable as to bulk, and less as to weight, one may, without a naked fire, and in a glass retort, sublime gold, (not prepared by previous calcination) sometimes in the form of a yellow or golden coloured salt; and sometimes, when the operation succeeded better, in the form of thin crystals prettily shaped, glossy, and as red as rubies. But this upon the by; it may perhaps be more useful to searchers of rich fossils not found in lumps, if I take this occasion to observe, that when they meet with sands, earths, mineral fragments, &c. that considerably exceed crystal in specific gravity; and by the place, wherein they are found, or by other tokens, give hopes of their containing corpuscles of a golden nature: when this, I say, happens, it will not be advisable, hastily to reject such bodies, but rather carefully to try, whether they do not deserve a better usage. For having sometimes had the opportunity to discover corpuscles of *Mars*, as chemists call iron and steel, in a far greater variety of fossils and of disguises, than even many noted chemists would have imagined, or some of them could, upon heedful trial, discover; I was much confirmed in my suspicion, that corpuscles of a golden nature may be concealed in divers bodies, which are thought not to contain any metal; and that in more of those minerals, that are looked upon as ores of some other metal, because of its being manifestly predominant, there may be mingled pretty store of particles of gold or silver; which (because of
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the greater quantity of that other metal, or mineral, that doth, as it were, cover or disguise them) lie unperceived, and usually unsuspected, by persons not very well acquainted with such matters; and yet may, by one that is very skilful, be separated even with profit.

S E C T. XV.

BUT the grounds of the forementioned suspicion being as yet but conjectural, I shall decline the particular mention of them in this place; and shall rather advise, with reference to ores in general, that those, that would apply the hydrostatics to them, do labour to procure samples of the ores of differing mines, especially if they be found in the same country; and do either by trial, or strict enquiry, inform themselves, what proportion of the metal, that denominates them, they contain. For these proportions of ores and minerals being carefully weighed in air and water, and their specific gravities being thereby made known, they may serve for a kind of standard, by comparison whereto we may oftentimes make not altogether unuseful estimates of the metalline portions contained in other parcels of ore, of that species, whether afforded by the same mine, or vein of it, or by any other of the same metal hydrostatically examined.

For instance, our English lead ores, that are worth taking notice of, may be, for distinction sake, divided into three kinds or orders, and in each of these there may be allowed a latitude for greater or lesser degrees of goodness. The first sort is of those ores, that, in the ordinary way of melting, hold some of them from 30 lb. of lead in an hundred weight of ore, to 40; and others to 45 lb. of the same metal, and these by several are slighted as mean, and scarce, if at all, worth working, especially those, that hold under 35 or 40. As for the second sort, that reaches from 45 to 60 lb. in the hundred, the most usual proportion I have found in many trials hath been about half the weight of the ore in clean and malleable lead. These ores are thought indifferently good, and worth working: but other ores comprised in this second sort held about 55, and some near 60, and these were looked upon, not only as good, but pretty rich. And for the third sort, it consists of those, that yield from 60 to 80 in the hundred, and these ores are justly reputed very rich, (in lead) especially these that come any thing near 80; for I confess, I never met with any that reached so far, but was assured by an ingenious and skilful gentleman, master of his majesty's royal mint, that he had found some such upon trial. But for me, I think that I have not above twice or thrice met with any that yielded me above 75. These looked exceedingly promising, as if they were all metal, and I observed, whether the thing were casual or not, some lumps to be composed of divers great cubes like dice, sticking very hard to one another.

THE considerations, that moved me to offer the advice given at the beginning of this section, invited me to make researches of the specific gravity, not only of divers English ores, as of lead, tin, &c. of which I had carefully made a collection, (that was lost by a sudden fire, broke out in the place where I kept them) but of the ores, that were presented me from several countries, both in *Europe* and *America*; as Swedish copper and iron ores, German silver and tin glass ores; Hungarian antimonial ores; *New-England* lead, iron, and copper ores, &c. The effects of some few of which researches, that chanced to come to hand, whilst I was seeking for some hydrostatical trials of drugs, I thought it not amiss to insert in a table annexed to the *Medicina Hydrostatica*; because perhaps they may be of some use in making a previous conjecture, about a mine's being, or not being likely to be wrought with profit, all other things

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concurring that should do so. Which last clause I desire should be taken notice of, because there are divers other circumstances, besides the proportion of the metalline part in the fossil, that are fit to be considered, [as the plenty or scarcity of the mineral, the easiness or difficulty of coming at it, because of its depth, or its being or not being troubled with waters, &c. its nearness to plenty of fuel, and the conveniency of water to drive mills; its nearness to, or remoteness from, the sea, or some navigable river, convenient for its transportation, to omit other important circumstances] before one begins to work a mine; which, as they happen to be commodious or inconvenient, may render the attempt adviseable or imprudent.

BUT, Sir, I perceive (though late) that I have forgot I was to write, not a book of the trial of ores and other minerals, but a moderately sized letter about an hydrostatical way of exploring their specific gravity. And therefore, to avoid increasing the already too great prolixity of this paper, by making an apology for it, I shall lengthen it, only to beg you to pardon it, and to look upon the writer as,

S I R,

Your most humble and obedient servant,

R. B.

ADVERTISEMENT.

TO give the curious the satisfaction of seeing at one view, and of so easily comparing together the specific gravities of a good number and variety of bodies, and to save them the labour of turning over many leaves of the foregoing tract, to find the particular body, whose ponderosity they desire to know; I have caused to be annexed a table, containing in an alphabetical order (though not a scrupulously exact one) the names of the drugs, and other bodies, whose gravities are delivered in the foregoing papers, without scrupling to add some others, that I chanced to light on in turning over some of my old and forgotten notes.

BUT I must to the following table premise this advertisement, (warranted by several passages of the foregoing papers here laid together) that it is not to be expected, every one, that shall try the specific gravities of the bodies here mentioned, shall find all of them to be precisely the same, that the table exhibits: since (not to mention, that perhaps every experimenter will not employ so much care, and be assisted with so much use, in making hydrostatical trials, as those this table consists of were made with) the difference, that may sometimes be found between his trials and mine, may very probably be imputed to that variety of texture and compactness, that may be found in several bodies of the same kind or denomination, neither nature nor art being wont to give all the productions, that bear the same name, a mathematical preciseness, either in gravity or in other qualities.

The T A B L E.

	A	Weight		Proportion.
		In air in gr.	In water in gr.	
AMBER	_____	306	12	$1\frac{4}{100}$ to 1.
Agat	_____	251	156	$2\frac{64}{100}$ to 1.
A piece of alum-stone	_____	$280\frac{1}{4}$	$152\frac{1}{4}$	$2\frac{13}{100}$ to 1.
Antimony good and supposed to be Hungarian one	—	391	295	$4\frac{7}{100}$ to 1.
Vol. V.	T t t			Bezoar.

The T A B L E.

			Weight		Proportion.
			In air in gr.	In water in gr.	
B					
Bezoar-stone	—	—	187	61	$1\frac{48}{100}$ to 1.
A piece of the same	—	—	$56\frac{1}{2}$	22	$1\frac{64}{100}$ to 1.
A fine oriental one	—	—	172	60	$1\frac{53}{100}$ to 1.
Another	—	—	237	61	$1\frac{34}{100}$ to 1.
C					
Coral red	—	—	$129\frac{1}{4}$	$80\frac{1}{4}$	$2\frac{63}{100}$ to 1.
Cryſtal	—	—	256	140	$2\frac{21}{100}$ to 1.
Cornelian	—	—	148	103	$3\frac{29}{100}$ to 1.
Calculus humanus	—	—	2570	1080	$1\frac{72}{100}$ to 1.
Coco-shell	—	—	331	85	$1\frac{34}{100}$ to 1.
Native crabs eyes	—	—	$77\frac{1}{2}$	$36\frac{1}{2}$	$1\frac{89}{100}$ to 1.
Crabs eyes artificial	—	—	$90\frac{1}{2}$	54	$2\frac{48}{100}$ to 1.
Calx of lead	—	—	$138\frac{1}{2}$	123	$8\frac{94}{100}$ to 1.
Copper-stone	—	—	$65\frac{1}{2}$	$49\frac{1}{2}$	$4\frac{9}{100}$ to 1.
Common cinnabar	—	—	802	702	$8\frac{1}{50}$ to 1.
Cinnabar of antimony	—	—	197	169	$7\frac{3}{100}$ to 1.
Cinnabar native	—	—	197	171	$7\frac{57}{100}$ to 1.
Coral white	—	—	336	204	$2\frac{54}{100}$ to 1.
Another piece fine	—	—	139	85	$2\frac{57}{100}$ to 1.
Calculus humanus	—	—	302	97	$1\frac{47}{100}$ to 1.
Copper ore	—	—	1436	1090	$4\frac{15}{100}$ to 1.
Copper ore rich	—	—	413	314	$4\frac{17}{100}$ to 1.
Cinnabar native, very sparkling	—	—	226	194	$7\frac{6}{100}$ to 1.
G					
Gold ore not rich, brought from the <i>East-Indies</i>	—	—	1100	682	$2\frac{63}{100}$ to 1.
Another lump of the same	—	—	1151	717	$2\frac{65}{100}$ to 1.
Granati Minera	—	—	217	147	$3\frac{1}{100}$ to 1.
Granate Bohemian	—	—			$4\frac{36}{100}$ to 1.
H					
Hæmatites Engliſh	—	—	1574	1156	$3\frac{76}{100}$ to 1.
I					
Ivory	—	—	$173\frac{1}{2}$	83	$1\frac{91}{100}$ to 1.
L					
Lapis manati	—	—	450	293	$2\frac{86}{100}$ to 1.
A fragment of the same	—	—	$218\frac{1}{2}$	123	$2\frac{29}{100}$ to 1.
Another	—	—	345	197	$2\frac{33}{100}$ to 1.
Another from <i>Jamaica</i>	—	—	2011	1127	$2\frac{27}{100}$ to 1.
Lapis lazuli one piece	—	—	385	256	$2\frac{98}{100}$ to 1.
Lead ore	—	—	686	590	$7\frac{14}{100}$ to 1.
Another	—	—			
Lapis calaminaris	—	—	477	380	$4\frac{92}{100}$ to 1.
Lapis judaicus	—	—	$261\frac{1}{2}$	164	$2\frac{69}{100}$ to 1.
M					
Marcaſites	—	—	814	631	$4\frac{45}{100}$ to 1.
Another from <i>Stalbridge</i>	—	—	243	189	$4\frac{1}{2}$ to 1.
Another more ſhining than ordinary	—	—	287	227	$4\frac{78}{100}$ to 1.
Mercury revived from ore	—	—			

			Weight		Proportion.
			In air in gr.	In water in gr.	
Manganefe a piece	—	—	321	230	$3\frac{53}{100}$ to 1.
Mineral Cornish like a shining marcasite	—	—	145	129	$9\frac{16}{100}$ to 1.
O					
Osteocolla	—	—	195	108	$2\frac{24}{100}$ to 1.
Ore silver choice from Saxony	—	—	458	366	$4\frac{97}{100}$ to 1.
Another piece	—	—	1120	960	7 to 1.
Ore lead from Cumberland rich	—	—	1872	$1586\frac{1}{2}$	$1\frac{54}{100}$ to 1.
R					
Rhinoceros horn	—	—	8563	4260	$1\frac{99}{100}$ to 1.
Rock-cryftal, another piece	—	—	256	140	$2\frac{20}{100}$ to 1.
S					
Sapphir					
Seed pearl					
Sulphur vive	—	—	371	185	2 to 1.
Germane very fine	—	—	306	152	$1\frac{98}{100}$ to 1.
Slate Irish	—	—	779	467	$2\frac{49}{100}$ to 1.
T					
A piece of talc-like lapis amianthus	—	—	596	334	$2\frac{28}{100}$ to 1.
Talc	Venetian	—	802	508	$2\frac{73}{100}$ to 1.
	Jamaican	—	1857	1238	3 to 1.
New English tin ore, Mr. Hubert's	—	—	812	613	$4\frac{8}{100}$ to 1.
Tin ore black rich	—	—	1293	984	$4\frac{18}{100}$ to 1.
Another piece choice	—	—	2893	2314	5 to 1.
Tutty a piece	—	—	104	83	5 to 1.
Tin-glafs	—	—	468	419	$9\frac{55}{100}$ to 1.
V					
Vitrum Antimonii per fe	—	—	$357\frac{1}{2}$	$282\frac{1}{2}$	$4\frac{76}{100}$ to 1.
Vitriol English, a very fine piece	—	—	1093	512	$1\frac{88}{100}$ to 1.
Unicorns horn a piece	—	—	407	195	$1\frac{91}{100}$ to 1.

P O S T S C R I P T.

WHEN I began to fend the essay, called *Medicina Hydrostatica*, to the press, and drew up the foregoing preface to it, I intended it should, in the same book or volume, be accompanied by another help or two, to explore and improve the *Materia Medica*. But when the essay itself, and the annexed epistle about a previous exploration of ores, had been printed off, I could not but perceive, that the bulk of those two tracts so far exceeded what I expected, that, if I subjoined what I at first designed to add to it, it would prove a mis-shapen book, and inconvenient to be opened. Wherefore it seemed expedient to divide the whole intended work into two volumes or tomes, whereof what had already past the press should make the first, which, that it might be the sooner serviceable, should forthwith come abroad by itself; and the second should consist partly of the other papers above-mentioned, as relating to the *Materia Medica*, and partly of a supplement to the first tome, containing divers historical paralipomena, that by mistake were omitted, and are fit to be there supplied out of a fuller copy, than that, which by an oversight was made use of at the press.

THE CHRISTIAN VIRTUOSO:

S H E W I N G,

That, by being addicted to Experimental Philosophy, a man is rather assisted
than indisposed to be a good Christian.

The F I R S T P A R T.

To which are subjoined,

- I. A discourse about the distinction, that represents some things as above reason, but not contrary to reason.
 - II. The first chapters of a discourse, entitled, Greatness of Mind promoted by Christianity.
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The P R E F A C E.

WHEN many years ago I was induced to write something about the subject of the following treatise, I did it partly to give some satisfaction to a friend, and partly to impose upon myself an obligation, to consider the more attentively, upon what grounds it may be asserted, that there is no inconsistency between a man's being an industrious virtuoso, and a good Christian. How little fond I was of troubling the public with a discourse of this nature, may be guessed by my having thrown it aside, among other neglected papers, for several years. And it had still continued in that obscurity, if the formerly unprevailing desires of those, that would have it appear in public, had not been enforced by an observation or two, that I could not but make. For I could scarce avoid taking notice of the great and deplorable growth of irreligion, especially among those, that aspired to pass for wits, and several of them too for philosophers. And on the other side it was obvious, that divers learned men, as well as others, partly upon the score of their abhorrence of these infidels and libertines, and partly upon that of a well-meaning but ill-formed zeal, had brought many good men to think, that religion and philosophy were incompatible; both parties contributing to the vulgar error, but with this difference, that the libertines thought a virtuoso ought not to be a Christian, and the others, that he could not be a true one.

It is like it may seem to some readers, that I have too much enlarged the notion of experience, and too much insisted on the proofs deducible from that topic: but it is not improbable, that others may approve the reasons, with which that ample notion of experience is, where it is proposed, accompanied. And the ingenious person, I was chiefly to please, being a lover and valuer of experience, and of arguments grounded on it, the desire of gratifying him enticed me to say so much, that when I took up the thoughts of making this treatise public, I found the effects of my complaisance so interwoven with the other parts of the discourse, that I could

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not make any great alteration, (for some I did make) without almost spoiling the contexture of it.

I HOPE the equitable reader will not expect to find every subject, of which I have occasion to discourse, fully treated of: for I neither designed nor pretended to write a body of natural theology, nor a demonstration of the Christian religion, but thought it sufficient for me to consider the points I wrote of, as far forth as was necessary or very conducive to my purpose. And therefore I thought myself not only warranted, but obliged, (in point of discretion) to decline the mention of several arguments and reflections, that would indeed have been very proper, if my design had been to shew, why one should be a Christian; but impertinent to shew, that a virtuoso, while such, may be a true Christian. But as, for this reason, I omitted many things, that would have enriched or adorned my discourse; so I have endeavoured to make some amends, both by suggesting some new subjects, and by adding, on those that have been already treated of by others, divers thoughts, into which I was led by the attentive consideration of the subject itself; on which score, they may probably not have yet occurred to the reader, and may appear to him, either to be new as to the substance, or, if any of them be coincident with the more known ones, to have something peculiar as to the way of propounding or of applying them. And, I confess, I was somewhat encouraged to communicate my thoughts on these subjects, by considering, that (though it ought not to be so, yet) it is notorious, that, in the age we live in, there are too many persons, that are like to be found more indisposed to be impressed on by arguments, in favour of religion, from professed divines, how worthy soever, than from such as I, who am a layman, and have been looked upon as no undiligent cultivator of experimental philosophy. And (that the stile might not be unsuitable to the writer, and the design) I thought fit, in my arguments and illustrations, both to employ comparisons drawn from telescopes, microscopes, &c. and to make frequent use of notions, hypotheses, and observations, in request among those, that are called the new philosophers. Which I the rather did, because some experience has taught me, that such a way of proposing and elucidating things, is either more clear, or, upon account of its novelty, wont to be more acceptable, than any other to our modern virtuosi; whom thus to gratify, is a good step towards the persuading of them. For it is easy to observe, that some men are more accessible to truth, and will be more prevailed upon by it, when it is presented to them in one dress, than when it appears in another; as we daily see, that some persons will be more easily prevailed with to take a medicine, and that it will have a more kindly operation upon them, if it be exhibited in that form and consistence, that is best liked by the patients; whereof some love to have the ingredients (the medicine is to consist of) offered them in a liquid, others in a soft, and others in a dry form.

THOUGH I am wont, as well as inclinable, to spare the present age; and though my censures of some reputed virtuosi, that live in it, are written with as harmless and friendly designs, as was the seeming rudeness of the angel to St. *Peter*, when he struck him on the side, and hastily roused him, but to awake him, to take off his chains, and to free him from the danger that threatened him; yet I shall be more troubled and surpris'd, if I shall find the following treatise disliked by divers persons, that would pass for virtuosi, and by some that are really so. For some men, that have but superficial (though conspicuous) wits, are not fitted to penetrate such truths, as require a lasting and attentive speculation; and divers, that want not abilities, are so taken up by their secular affairs, and their sensual pleasures, that they neither have disposition, nor will have leisure, to discover those truths, that require both an attentive and penetrating mind. And more than either of these sorts of men there

are,

are, whom their prejudices do so forestal, or their interest bias, or their appetites blind, or their passions discompose, too much to allow them a clear discernment and right judgment of divine things. Upon which (and other) accounts, I shall not think it strange, if what I write shall make no great impression on readers thus qualified, whom to convert, it is not enough to convince them: nor shall I be greatly discouraged, or think much the worse of my arguments, if they do not make profelytes of those, whom sinister considerations make such resolved adversaries to the truth, that He alone, who can preach from heaven, is able to prevail upon them; and they must be converted almost as *Saul* the persecutor was, by an extraordinary light from heaven, and a power able to strike them to the ground. But though I am not so little acquainted with the present age, as to expect to plead for religion with the approbation of atheists, or of libertines; yet I shall not think my pains altogether mispent, if what I have written, either startle any irreligious reader so far, as to engage him to consult abler assertors of Christianity and virtue, than I pretend to be; or else prove so happy, as to confirm and strengthen, by new arguments and motives, those that have heartily embraced the Christian faith and morals, though perhaps not upon the firmest grounds. For it will be no small satisfaction to me, if, though I cannot convert the resolutely irreligious, I shall at least furnish those, that are not so, with preservatives against them, and hinder their impiety from being contagious.

BUT I fear, that those, that are enemies both to the doctrines I propose, and to the aims I pursue, will not be the only persons, that will find fault with the following tract; since, perhaps, there will not be wanting some ingenious men, that expected, as well as desired, that I should never write but as a naturalist, because they themselves esteem nothing, save the laws and phaenomena of nature, to be subjects worthy of a philosophical pen: as if, because rational spirits are invisible and immaterial beings, all disquisitions about them must be airy and uncertain speculations, and, like their objects, devoid of solidity and usefulness. But though among these ingenious men there are several, whose expectations from me I am much more disposed to gratify, than disappoint; yet, on such an occasion as this, I must take the liberty to own, that I do not think the corporeal world, nor the present state of things, the only or the principal subjects, that an inquisitive man's pen may be worthily employed about; and that there are some things, that are grounded neither upon mechanical nor upon chemical notices or experiments, that are yet far from deserving to be neglected, and much less to be despised, or so much as to be left uncultivated, especially by such writers, as being more concerned to act as Christians, than as virtuosi, must also think, that sometimes they may usefully busy themselves about the study of divine things, as well as at other times employ their thoughts about the inspection of natural ones. There are some objects, whose nobleness is such, that, though we derive no advantage from them, but the contentment of knowing them, and that but very imperfectly too, yet our virtuosi themselves justly think much pains and time, and perhaps cost too, well spent in endeavouring to acquire some conjectural knowledge of them: as may be instanced in the assiduous and industrious researches they have made about the remote coelestial part of the world, especially the stars and comets, that our age has exposed to their curiosity. For most of these, though they require chargeable telescopes, and tedious (as well as unhealthy) nocturnal observations, are objects, of which we can know very little with any certainty; and which, for ought appears, we can make no useful experiments with. Since therefore we so much prize a little knowledge of things, that are not only corporeal, but inanimate; methinks we should not undervalue the studies of those men, that aspire to the knowledge of incorporeal and rational beings, which are incomparably more noble than all the stars in

in the world, which are, as far as we know, but masses of senseless and stupid matter. Since also the virtuosi deservedly applaud and cherish the laborious industry of anatomists, in their inquiries into the structure of dead, ghastly, and oftentimes unhealthfully as well as offensively foetid bodies; can it be an employment improper for a Christian virtuoso, or unworthy of him, to endeavour the discovery of the nature and faculties of the rational mind, which is that, that ennobles its mansion, and gives man the advantage he has of the beasts that perish?

I AM content, that merely natural philosophy should often employ my thoughts and my pen; but I cannot consent it should engross them, and hinder me from being conversant with theological subjects. And since, among my friends, I have some (and those not inconsiderable for their number, and much less for their merit) that press me to treat of religious matters, as well as others, that would have me addict myself to cultivate physical ones; I, who think myself a debtor to both these sorts, am willing to endeavour to gratify both; and having already, on many occasions, presented the latter sort with large, as well as public, effects of my complaisance for them, I hope, they will not think it strange, that I should now and then have regard to the former sort, too; especially since I had higher motives, than complaisance ought to be, to induce me to treat sometimes of things, that might be grateful to those friends, that are much so to religious compositions.

I PRESUME it will be taken notice of, that, in the following treatise, as well as in divers of my other writings, especially about subjects that are purely, or partly, philosophical, I make frequent use of similitudes, or comparisons: and therefore I think myself here obliged to acknowledge once for all, that I did it purposely. And my reasons for this practice were, not only because fit comparisons are wont to delight most readers, and to make the notions they convey better kept in memory; whence the best orators and preachers have made great and successful use of metaphors, allegories, and other resemblances; but I was induced to employ them chiefly for two other reasons: 1. That though I freely confess, that arbitrary similitudes, and likewise those that are foreign to the subject treated of, such as are most of the vulgar ones, that are usually borrowed from the fictions of the poets, and from the uncertain and often ill-applied relations of *Pliny*, *Ælian*, and other too frequently fabulous writers, are scarce fit to be made use of but to vulgar readers, or popular auditories; yet comparisons fitly chosen, and well applied, may, on many occasions, usefully serve to illustrate the notions, for whose sake they are brought, and, by placing them in a true light, help men to conceive them far better than otherwise they would do. And, 2. apposite comparisons do not only give light, but strength, to the passages they belong to, since they are not always bare pictures and resemblances, but a kind of arguments; being oftentimes, if I may so call them, analogous instances, which do declare the nature, or way of operating, of the thing they relate to, and by that means do in a sort prove, that, as it is possible, so it is not improbable, that the thing may be such as it is represented: and therefore not only the illustrious *Verulam*, though not more a florid than a judicious writer, has, much to the satisfaction of his readers, frequently made use of comparisons, in whose choice and application he was very happy; but that severe philosopher, monsieur *Des Cartes* himself, somewhere says, that he scarce thought, that he understood any thing in physics, but what he could declare by some apt similitude; of which, in effect, he has many in his writings; [as where he compares the particles of fresh water to little eels; and the corpuscles of salt in the sea-water to little rigid staves; and where, after the Stoics, he compares the sense of objects, by the intervention of light, to the sense that a blind man hath of stones, muds, &c. by the intervention of his staff.] To which I shall add, that

proper

proper comparisons do the imagination almost as much service as microscopes do the eye; for, as this instrument gives us a distinct view of divers minute things, which our naked eyes cannot well discern, because these glasses represent them far more large, than by the bare eye we judge them; so a skilfully chosen and well applied comparison much helps the imagination, by illustrating things scarce discernible, so as to represent them by things much more familiar and easy to be apprehended.

I CONFESS I might, on some occasions, have spoken, not only more positively and boldly, but, as to many learned readers, more acceptably, if I would have discoursed altogether like a Cartesian, or as a partizan of some other modern sect of philosophizers. But, besides that I am not minded to give myself up to any sect, I thought it convenient, that a discourse, designed to work on persons of differing persuasions about philosophical matters, should not declare itself dogmatically, or unreservedly, of a party; but employ rather the dictates of reason, or principles either granted or little contested, than proceed upon the peculiar principles of a distinct party of philosophizers.

IF now and then I have insisted upon some particular subjects, more than appears absolutely necessary, I did it, because that, though I wrote this treatise chiefly for my friends, yet I did not write it for them only, but was willing to lay hold on some of the occasions, that the series of my discourse offered me, to excite in myself those dispositions, that I endeavoured to produce in others, and, by insisting upon some reflections, impress them more deeply upon my own mind; especially when I was treating of some points, either so important, or so opposed, or both, that they can scarce be too much inculcated.

THE name of the person, to whom the following papers were addressed, not being necessary to be made public, some reasons made it thought convenient, that it should remain unmentioned.

P O S T S C R I P T.

TO give an account of the prolixity, that some might otherwise censure, of the foregoing preface, I must advertise the reader, that it is of an ancient date; and that the first part of the treatise, that it belongs to, was already written, and it was then designed, that the second part should accompany it to the press: on which score it was presumed, that, as the particulars, that make up the preamble, would not appear superfluous, in regard of the variety of subjects to be treated of; so its length would scarce be found disproportionate to the bulk of the whole designed book.

T H E C H R I S T I A N V I R T U O S O :

S H E W I N G,

That, by being addicted to Experimental Philosophy, a man is rather assisted than indisposed to be a good Christian.

The F I R S T P A R T.

S I R,

I PERCEIVE by what you intimate, that your friends Dr. *W.* and Mr. *N.* think it very strange, that I, whom they are pleased to look upon as a diligent cultivator of experimental philosophy, should be a concerned embracer of the Christian religion; though

though divers of its articles are so far from being objects of sense, that they are thought to be above the sphere of reason. But though I presume they may find many objects of the like wonder, among those with whom I am comprised by them, under the name of the new virtuosi; and among these, they may meet with divers persons more able than I, to ease them of their wonder; yet since they are pleased, by singling me out, as it were to challenge me to do it, I shall endeavour to make them think it at least less strange, that a great esteem of experience, and a high veneration for religion, should be compatible in the same person. Wherefore I shall not deny, that I am now and then busied in devising, and putting in practice, trials of several sorts, and making reflections upon them: and I own too, that (about natural things) I have a great reverence for experience, in comparison of authority. But withal I declare, that, to embrace Christianity, I do not think I need to recede from the value and kindness I have for experimental philosophy, any thing near so far as your friends seem to imagine. And I hope it will appear, that if the experimental way of philosophising I am addicted to, have any things in it, that indispose a man to assent to the truth, and live according to the laws of the Christian religion; those few things are more than countervailed by the peculiar advantages, that it affords a man of a well-disposed mind, towards the being a good Christian.

I SAID, a man of a well-disposed mind, that is, one, that is both docile, and inclined to make pious applications of the truths he discovers; because such a qualification of mind, I hope, God, through his goodness, has vouchsafed me; and the occasion given by your friends to the following discourse relating peculiarly to me, a personal account of my opinions, and reasons of them, ought to suffice. And it will be *ex abundanti*, (as they speak) if my discourse be found, as it often will be, to extend much further. Which reflection I desire you would frequently have in your thoughts, to prevent mistaking the design of the following epistle.

I DOUBT not, but the popular prejudices, that I perceive your two friends, among many other more devout than well-informed persons, have entertained, will make them think, that what I have now delivered needs good proof, and perhaps better than it is capable of. And therefore I hope you will easily allow me the liberty, I am going to take, of briefly premising some things, to clear the way for the principal points designed to be discoursed of in this letter.

I KNOW you need not be told, that the philosophy, which is most in request among the modern virtuosi, and which by some is called the new, by others the corpuscularian, by others the real, by others (though not so properly) the atomical, and by others again the Cartesian (or the mechanical) philosophy, is built upon two foundations, reason and experience. But it may not be impertinent to observe to you, that although the peripatetic (and some other) philosophies do also pretend to be grounded upon reason and experience; yet there is a great difference betwixt the use, that is made of these two principles, by the school-philosophers, and by the virtuosi. For those, in the framing of their system, make but little use of experience; contenting themselves for the most part to employ but few and obvious experiments, and vulgar traditions, usually uncertain, and oftentimes false; and superstructing almost their whole physics upon abstracted reason; by which I mean the rational faculty, endowed but with its own congenit, or common notions and ideas; and with popular notices, that is, such as are common among men, especially those that are any thing learned. But now, the virtuosi I speak of (and by whom, in this whole discourse, I mean those that understand and cultivate experimental philosophy) make a much greater and better use of experience in their philosophical researches. For they consult experience both frequently and heedfully; and, not content with the phænomena that nature

spontaneously affords them, they are solicitous, when they find it needful, to enlarge their experience by trials purposely devised; and, ever and anon reflecting upon it, they are careful to conform their opinions to it; or, if there be just cause, reform their opinions by it. So that our virtuosi have a peculiar right to the distinguishing title, that is often given them, of experimental philosophers.

I CAN scarce doubt, but your friends have more than once obliged you to take notice of the profane discourses and licentious lives of some virtuosi, that boast much of the principles of the new philosophy. And I deny not, but that, if the knowledge of nature falls into the hands of a resolved atheist, or a sensual libertine, he may misemploy it to oppugn the grounds, or discredit the practice, of religion. But it will fare much otherwise, if a deep insight into nature be acquired by a man of probity and ingenuity, or at least free from prejudices and vices, that may indispose him to entertain and improve those truths of philosophy, that would naturally lead him to sentiments of religion. For, if a person thus qualified in his morals, and thereby disposed to make use of the knowledge of the creatures to confirm his belief, and increase his veneration of the Creator (and such a person, I here again advertise you, and desire you would not forget it, I suppose the virtuoso, this paper is concerned in, to be) shall make a great progress in real philosophy; I am persuaded, that nature will be found very loyal to her Author; and, instead of alienating his mind from making religious acknowledgments, will furnish him with weighty and uncommon motives, to conclude such sentiments to be highly rational and just. On which occasion I must not pretermitt that judicious observation of one of the first and greatest experimental philosophers of our age, Sir *Francis Bacon*, that God never wrought a miracle to convince atheists; because in his visible works He had placed enough to do it, if they were not wanting to themselves. The reason he gives for which remark, I shall confirm, by observing, that it is intimated in a passage of *St. Paul*, asserting
 Rom. i. 20. both “ that the invisible things of God are clearly seen from the creation of the
 “ world,” as tokens and effects (as I remember the particle *ἀπό* in the Greek doth elsewhere signify) and that his divinity and eternal power may be so well understood by the things that are made, that the Gentiles, who had but the light of nature to lead them to the acknowledgment of the true God, were excuseless, for not being brought by that guide to that acknowledgment.

AND indeed, the experimental philosophy giving us a more clear discovery, than strangers to it have, of the divine excellencies displayed in the fabric and conduct of the universe, and of the creatures it consists of, very much indisposeth the mind to ascribe such admirable effects to so incompetent and pitiful a cause as blind chance, or the tumultuous jostlings of atomical portions of senseless matter; and leads it to the acknowledgment and adoration of a most intelligent, powerful, and benign Author of things, to whom alone such excellent productions may, with the greatest congruity, be ascribed. And therefore, if any of the cultivators of real philosophy pervert it to countenance atheism, it is certainly the fault of the persons, not the doctrine; which is to be judged of by its own natural tendency, not by the ill use that some bad men may make of it; especially if the prevaricating persons are but pretenders to the philosophy they misemploy; which character will perhaps be found to belong to most, if not all, the atheistical and profane men, the objection means. For most of these do as little understand the mysteries of nature, as believe those of Christianity; and of divers of them it may be truly said, that their sensuality, and lusts, and passions, darkened and seduced their intellects: their immorality was the original cause of their infidelity; nor were they led by philosophy to irreligion, but got and perverted some smattering of philosophy, to countenance the irreligious principles they brought with them to the study of it.

BUT

BUT all this notwithstanding, I fear, if not foresee, that you will surmise, that the study of natural philosophy, how innocent soever it may be in itself, will, in this libertine city, engage me to converse with many, who, though they pass for virtuosi, are indeed atheists; whose contagious company must endanger (if not infect) me.

THIS obliges me to tell you, that though I have no reason to take it at all unkindly, that you are jealous of me on the score of being solicitous for my safety; yet I hope my danger is not so great as you may apprehend it. For first, I must own to you, that I do not think there are so many speculative atheists, as men are wont to imagine. And though my conversation has been pretty free and general among naturalists, yet I have met with so few true atheists, that I am very apt to think, that mens want of due information, or their uncharitable zeal, has made them mistake or misrepresent many for deniers of God, that are thought such, chiefly because they take uncommon methods in studying his works, and have other sentiments of them than those of vulgar philosophers. And in the next place I must tell you, that having, through the goodness of God, chosen my religion, not inconsiderately, but upon mature deliberation, I do not find those virtuosi, you call atheists, such formidable adversaries, as those that are afraid to hear them, do, by that apprehension, appear to think them. And indeed, I have observed the physical arguments of the atheists to be but very few, and those far enough from being unanswerable. And as for the very chief of them, though they are wont to puzzle such as are not versed in nice speculations, because they represent the assertion of a Deity as a doctrine encumbered with inextricable difficulties; yet I do not think the objections solidly grounded, since the same difficulties, or others not inferior, may be urged against those hypotheses and principles, that the deniers of God do or must admit. And indeed, most of the perplexing difficulties, the atheists lay so much stress on, do not proceed from any absurdity contained in the tenent of the theists, but from the nature of things; that is, partly from the dimness and other imperfections of our human understandings, and partly from the abstruse nature, that, to such bounded intellects, all objects must appear to have, in whose conception infinity is involved; whether that object be God, or atoms, or duration, or some other thing that is uncausable. For, however we may flatter ourselves, I fear we shall find, upon strict and impartial trial, that finite understandings are not able clearly to resolve such difficulties, as exact a clear comprehension of what is really infinite.

BUT to pursue this discourse would lead us too far. And it is more fit, after so much has been said, concerning not only the design of this tract, but the new philosophy, the virtuosi, and myself, to proceed to those more particular things, that directly tend to the main scope of our epistle.

THE first advantage, that our experimental philosopher, as such, hath towards being a Christian, is, that his course of studies conduceth much to settle in his mind a firm belief of the existence, and divers of the chief attributes, of God: which belief is, in the order of things, the first principle of that natural religion, which itself is pre-required to revealed religion in general, and consequently to that in particular, which is embraced by Christians.

THAT the consideration of the vastness, beauty, and regular motions, of the heavenly bodies; the excellent structure of animals and plants; besides a multitude of other phænomena of nature, and the subserviency of most of these to man; may justly induce him, as a rational creature, to conclude, that this vast, beautiful, orderly, and (in a word) many ways admirable system of things, that we call the world, was framed by an Author supremely powerful, wise, and good, can scarce be denied by an intelligent and unprejudiced considerer. And this is strongly confirmed by

experience, which witnesseth, that, in almost all ages and countries, the generality of philosophers, and contemplative men, were persuaded of the existence of a Deity, by the consideration of the phænomena of the universe; whose fabric and conduct, they rationally concluded, could not be deservedly ascribed, either to blind chance, or to any other cause than a divine Being.

BUT though it be true, "that God hath not left Himself without witness," even to perfunctory considerers, by stamping upon divers of the more obvious parts of his workmanship such conspicuous impressions of his attributes, that a moderate degree of understanding, and attention, may suffice to make men acknowledge his being; yet I scruple not to think that assent very much inferior to the belief, that the same objects are fitted to produce in an heedful and intelligent contemplator of them. For the works of God are so worthy of their Author, that besides the impresses of his wisdom and goodness, that are left as it were upon their surfaces, there are a great many more curious and excellent tokens and effects of divine artifice, in the hidden and innermost recesses of them; and these are not to be discovered by the perfunctory looks of oscitant or unskilful beholders; but require, as well as deserve, the most attentive and prying inspection of inquisitive and well-instructed considerers. And sometimes in one creature there may be I know not how many admirable things, that escape a vulgar eye, and yet may be clearly discerned by that of a true naturalist; who brings with him, besides a more than common curiosity and attention, a competent knowledge of anatomy, optics, cosmography, mechanics, and chemistry. But treating elsewhere purposely of this subject, it may here suffice to say, that God has couched so many things in his visible works, that, the clearer light a man has, the more he may discover of their unobvious exquisiteness, and the more clearly and distinctly he may discern those qualities, that lie more obvious. And the more wonderful things he discovers in the works of nature, the more auxiliary proofs he meets with to establish and enforce the argument, drawn from the universe and its parts, to evince that there is a God: which is a proposition of that vast weight and importance, that it ought to endear every thing to us, that is able to confirm it, and afford us new motives to acknowledge and adore the divine Author of things.

IN reference to this matter, we may confidently say, that the experimental philosophy has a great advantage of the scholastic. For in the peripatetic schools, where things are wont to be ascribed to certain substantial forms and real qualities; (the former of which are acknowledged to be very abstruse and mysterious things, and the latter are many of them confessedly occult); the accounts of nature's works may be easily given in a few words, that are general enough to be applicable to almost all occasions. But these uninformative terms do neither oblige nor conduct a man to deeper searches into the structure of things, nor the manner of being produced, and of operating upon one another; and consequently are very insufficient to disclose the exquisite wisdom, which the omniscient Maker has expressed in the peculiar fabrics of bodies, and the skilfully regulated motions of them, or of their constituent parts: from the discernment of which things nevertheless it is, that there is, by way of result, produced in the mind of an intelligent contemplator a strong conviction of the being of a divine Opificer, and a just acknowledgment of his admirable wisdom. To be told, that an eye is the organ of sight, and that this is performed by that faculty of the mind which from its function is called visive, will give a man but a sorry account of the instruments and manner of vision itself, or of the knowledge

Pl. xciv. 9. of that Opificer, who, as the Scripture speaks, "formed the eye." And he that can take up with this easy theory of vision, will not think it necessary to take the pains to dissect the eyes of animals, nor study the books of mathematicians, to under-stand

stand vision; and accordingly will have but mean thoughts of the contrivance of the organ, and the skill of the artificer, in comparison of the ideas, that will be suggested of both of them to him, that being profoundly skilled in anatomy and optics, by their help takes asunder the several coats, humours, and muscles, of which that exquisite dioptrical instrument consists: and having separately considered the figure, size, consistence, texture, diaphaneity, or opacity, situation, and connections of each of them, and their coaptation in the whole eye, shall discover, by the help of the laws of optics, how admirably this little organ is fitted to receive the incident beams of light, and dispose them in the best manner possible for completing the lively representation of the almost infinitely various objects of sight.

It is easy for men to say in general terms, that the world is wisely framed; but I doubt it often happens, that men confess, that the creatures are wisely made, rather because upon other grounds they believe God to be a wise agent, than because so slight an account, as the school philosophy gives of particular creatures, convinces them of any divine wisdom in the Creator. And though I am willing to grant, that some impressions of God's wisdom are so conspicuous, that (as I lately intimated) even a superficial philosopher may thence infer, that the author of such works must be a wise agent; yet how wise an agent he has in those works expressed himself to be, none but an experimental philosopher can well discern. And it is not by a slight survey, but by a diligent and skilful scrutiny of the works of God, that a man must be, by a rational and affective conviction, engaged to acknowledge with the prophet, that the author of nature is "wonderful in counsel, and excellent in working."

Isa. xxviii.
29.

II. AFTER the existence of the Deity, the next grand principle of natural religion, is the immortality of the rational soul; whose genuine consequence is, the belief and expectation of a future and everlasting state. For this important truth, divers arguments may be alledged, that may persuade a sober and well-disposed man to embrace it: but to convince a learned adversary, the strongest argument, that the light of nature supplies us with, seems to be that, which is afforded by the real philosophy. For this teacheth us to form true and distinct notions of the body, and the mind; and thereby manifests so great a difference in their essential attributes, that the same thing cannot be both. This it makes out more distinctly, by enumerating several faculties and functions of the rational soul; such as to understand, and that so, as to form conceptions of abstracted things, of universals, of immaterial spirits, and even of that infinitely perfect one, God himself: and also to conceive, and demonstrate, that there are incommensurable lines, and surd numbers; to make ratiocinations, and both cogent and concatenated inferences, about these things; to express their intellectual notions, *pro re natâ*, by words or instituted signs to other men; to exercise free will about many things; and to make reflections on its own acts, both of intellect and will. For these and the like prerogatives, that are peculiar to the human mind, and superior to any thing, that belongs to the outward senses, or to the imagination itself, manifest, that the rational soul is a being of an higher order than corporeal; and consequently, that the seat of these spiritual faculties, and the source of these operations, is a substance, that being in its own nature distinct from the body, is not naturally subject to die or perish with it.

AND in reference to this truth, our virtuoso hath an advantage of a mere school-philosopher. For being acquainted with the true and real causes of putrefaction, and other physical kinds of corruption; and thereby discerning, that the things, that destroy bodies, are the avolation, or other recess of some necessary parts, and such a depraving transposition of the component portions of matter, as is altogether incongruous to the structure and mechanical modification, that is essential to a body of that species:

species or kind it belongs to : our naturalist, I say, knowing this, plainly perceives, that these causes of destruction can have no place in the rational soul ; which being an immaterial spirit, and consequently a substance not really divisible, can have no parts expelled or transposed, and so being exempted from the physical causes of corruption that destroys bodies, she ought to last always. And being a rational creature, endowed with internal principles of acting, as appears in free-will, she ought to live for ever, unless it please God to annihilate her ; which we have no reason to suppose he will do. But on the other side, the modern peripatetics (for I question, whether *Aristotle* himself were of the same opinion) maintain substantial forms, by some of them stiled *semi substantiæ*, to which in apes, elephants, and others, that pass for ingenious animals, they ascribe some such faculties and functions, as seem to differ but gradually from those of the rational soul ; and (how innocent soever I grant their intentions to be) their doctrine tends much to enervate, if not quite to disable the chief physical way of probation, whence the immortality of man's mind is justly inferred. For since according to the peripatetics, substantial forms are, as they speak, endued out of the power or potentiality of the matter ; and do so depend upon it, not only as to action, but as to being, that they cannot at all subsist without it ; but when the particular body (as an herb, a stone, or a bird) is destroyed, they perish with it, or (as some of them scarce intelligibly express the same thing) fall back into the bosom of the matter : I think they give great advantage to atheists and cavillers, to impugn the mind's immortality.

FOR if to an ape, or other brute animal, there belongs a being more noble than matter, that can actuate and inform it, and make itself the architect of its own mansion, though so admirable as that of an ape, or an elephant ; if this being can in the body it hath framed, perform all the functions of a vegetable soul ; and besides those, see, hear, taste, smell, imagine, infer, remember, love, hate, fear, hope, expect, &c. and yet be a mortal thing, and perish with the body ; it will not be difficult for those enemies of religion, who are willing to think the soul mortal, because their brutish lives make them wish she were, to fancy, that human minds are but a somewhat more noble, but not for that less mortal kind of substantial forms, as amongst sensitive souls themselves, which they acknowledge to be equally mortal, there is a great disparity in degrees, that of a monkey, for instance, being very far superior to that of an oyster.

III. THE third main principle of unrevealed religion, and consequently of revealed, (which presupposes natural religion, as its foundation) is a belief of the divine providence. And in this grand article, as well as in the two foregoing, a man may be much confirmed by experimental philosophy, both as it affords him positive inducements to acknowledge the article, and as it shews the great improbability of the two main grounds, on one or other of which (for they are not well consistent) is founded the denial of God's providence.

A VIRTUOSO, that by manifold and curious experiments searches deep into the nature of things, has great and peculiar advantages to discover and observe the excellent fabric of the world, as it is an immense aggregate of the several creatures that compose it ; and to take notice in its particular parts, especially those that are animated, of such exquisite contrivances, and such admirable co-ordinations, and subordinations, in reference to each other, as lye hid from those beholders, that are not both attentive and skilful. When our virtuoso contemplates the vastness, scarce conceivable swiftness, and yet constant regularity of the various motions of the sun, moon, and other celestial lights ; when he considers, how the magnetism of the earth makes its poles constantly look the same way, notwithstanding the motions of its fluid vortex ; how by daily turning about its own center in four and twenty hours, it receives as much light, and
benefit

benefit from the sun, and all the glorious constellations of the firmament, as if they, with all the vast heavenly region they belong to, moved about it in the same time; how by its situation among them it enjoys the regular vicissitudes of day and night, summer and winter, &c. how the several parts of the sublunary world are mutually subservient to one another, and most of them (one way or other) serviceable to man; how excellently the bodies of animals are contrived; what various and congruous provision is made for differing animals, that they may subsist as long as they should, according to the institution of nature, by furnishing them, according to their respective natures, some with strength to take their food by force, others with industry to procure it by subtilty, some with arms, as horns, hoofs, scales, tusks, poisons, stings, &c. to defend themselves, and offend their enemies; some with wings or swiftness to fly from dangers; some with foresight to prevent them; some with craft, and perhaps strange fetches of it, to elude them; how being distinguished into two sexes, each of these is furnished with apposite organs for the propagation of the species, and with skill and kindness to nourish and train up their young ones, till they can shift for themselves; how admirable, and indeed astonishing, a process is gone through in the formation of the foetus, especially of a human one; how divers animals are endowed with strange instincts, whose effects sometimes seem much to surpass those of reason itself; though they are superadded to the mechanical structure of the animal, and argue a respect to things very remote from it, either in time, place, or both, and perhaps also to the grand fabric or system of the world, and the general œconomy of nature. When, as I was saying, a philosopher duly reflects on these things, and many others of the like import, he will think it highly rational to infer from them these three conclusions.

FIRST, that a machine so immense, so beautiful, so well contrived, and, in a word, so admirable as the world, cannot have been the effect of mere chance, or the tumultuous jostlings and fortuitous concourse of atoms, but must have been produced by a cause exceedingly powerful, wise, and beneficent.

SECONDLY, that this most potent Author, and (if I may so speak) Opificer of the world, hath not abandoned a master-piece so worthy of Him, but does still maintain and preserve it, so regulating the stupendiously swift motions of the great globes, and other vast masses of the mundane matter, that they do not, by any notable irregularity, disorder the grand system of the universe, and reduce it to a kind of chaos, or confused state of shuffled and depraved things.

THIRDLY, that as it is not above the ability of the divine author of things, though a single being, to preserve and govern all his visible works, how great and numerous soever; so he thinks it not below his dignity and majesty, to extend his care and beneficence to particular bodies, and even to the meanest creatures; providing not only for the nourishment, but for the propagation of spiders and ants themselves. And indeed, since the truth of this assertion, that God governs the world he has made, would appear (if it did not by other proofs) by the constancy and regularity, and astonishing rapid motions of the vast celestial bodies, and by the long trains of as admirable as necessary artifices, that are employed to the propagation of various sorts of animals, whether viviparous, or oviparous; I see not, why it should be denied, that God's providence may reach to his particular works here below, especially to the noblest of them, man; since most of those learned men, that deny this, as derogatory to God's majesty and happiness, acknowledge, that at the first creation, or (if they dislike that term) formation of things, the great author of them must not only have extended his care to the grand system of the universe in general, but allowed it to descend so low, as to contrive all the minute and various parts, (and even the most homely ones) not only of greater

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and (reputedly) more perfect animals, as elephants, whales, and men; but such small and abject ones, as flies, ants, fleas, &c. which being manifestly propagated by eggs laid by the female, cannot reasonably be thought the off-spring of putrefaction. Whence I gather, as from matter of fact, that to be concerned for the welfare, even of particular animals, as it is agreeable to God's all-pervading wisdom, and exuberant beneficence; so (whatever men's vanity may make them surmise) it is not truly derogatory to his adorable greatness and majesty.

Psalms
cxxxviii.
14, 15.

AND on this occasion, I shall add, that since man is the noblest of God's visible works; since very many of them seem made for his use; since, even as an animal, he is (as the Psalmist truly speaks) "wonderfully made," and curiously or artificially wrought; and since God has both given him a rational mind, and endowed it with an intellect, whereby he can contemplate the works of nature, and by them acquire a conviction of the existence, and divers attributes, of their supremely perfect author; since God hath planted notions and principles in the mind of man, fit to make him sensible, that he ought to adore God, as the most perfect of beings, the supreme lord and governor of the world, the author of his own nature, and all his enjoyments; since all this, I say, is so, natural reason dictates to him, that he ought to express the sentiments he has for this divine being, by veneration of his excellencies; by gratitude for his benefits; by humiliation, in view of his greatness and majesty; by an awe of his justice; by reliance on his power and goodness, when he duly endeavours to serve and please him; and, in short, by those several acts of natural religion, that reason shews to be suitable, and therefore due to those several divine attributes of his, which it has led us to the knowledge of.

AND here I shall take leave to add, that, from the Cartesian principles (which you know are embraced by a great part of the modern virtuosi) I think, I may draw a double argument for divine providence.

FOR first, according to the Cartesians, all local motion (which is, under God, the grand principle of all actions among things corporeal) is adventitious to matter, and was at first produced in it, and is still every moment continued and preserved immediately by God: whence may be inferred, that he concurs to the actions of each particular agent (as they are physical) and consequently, that his providence reaches to all and every one of them,

AND secondly, the same Cartesians believe the rational soul to be an immaterial substance, really distinct and separable from the body. Whence I infer, that the divine providence extends to every particular man; since whenever an embryo, or little human body formed in the womb, is, by being duly organised, fitted to receive a rational mind, God is pleased to create one, and unite it with that body. In which transaction, there seems to me a necessity of a direct and particular intervention of the divine power; since I understand not, by what physical charm or spell an immaterial substance can be allured into this or that particular embryo, of many that are at the same time fitted to receive a human soul; nor by what merely mechanical tie, or band, an immaterial substance can be so durably (perhaps for 80 or 100 years) joined and united with a corporeal, in which it finds no parts, that it has organs to take hold of, and to which it can furnish no parts to be fastened upon by them. Nor do I better conceive, how a mere body can produce pain, pleasure, &c. by its own mere action, or rather endeavour to act, on an immaterial spirit. Nor will the force of all that has been said for God's special providence, be eluded, by saying, with some deists, that after the first formation of the universe, all things are brought to pass by the settled laws of nature. For though this be confidently, and not without colour pretended; yet, I confess, it does not satisfy me. For, beside the insuperable difficulty there

there is, to give an account of the first formation of things, which many (especially Aristotelian) deists will not ascribe to God; and besides that the laws of motion, without which the present state and course of things could not be maintained, did not necessarily spring from the nature of matter, but depended upon the will of the divine author of things: besides this, I say, I look upon a law as a moral, not a physical cause, as being indeed but a notional thing, according to which, an intelligent and free agent is bound to regulate its actions. But inanimate bodies are utterly incapable of understanding what a law is, or what it enjoins, or when they act conformably or unconformably to it; and therefore the actions of inanimate bodies, which cannot incite or moderate their own actions, are produced by real power, not by laws; though the agents, if intelligent, may regulate the exertions of their power by settled rules.

IV. I HAVE taken notice of two other accounts, upon which the experimental knowledge of God's works may, in a well-disposed mind, conduce to establish the belief of his providence; and therefore, though I shall not dwell long upon them, I must not altogether pretermit them.

FIRST then, when our virtuoso sees how many, and how various, and oftentimes how strange, and how admirable structures, instincts, and other artifices, the wise Opificer hath furnished even brutes and plants withal, to purchase and assimilate their food, to defend or otherwise secure themselves from hostile things, and (to be short) to maintain their lives, and propagate their species; it will very much conduce to persuade him, that so wise an Agent, who has at command so many differing and excellent methods and tools, to accomplish what he designs, and does oftentimes actually employ them, for the preservation and welfare of beasts, and even of plants, can never want means to compass his most wise and just ends, in relation to mankind; being able, by ways that we should never dream of, to execute his menaces, and fulfil his promises. But of these rare structures, instincts, and other methods, and, if I may so stile some of them with reverence, stratagems and fetches of divine skill, that God is pleased to employ in the conduct of the visible world, especially animals, I have already elsewhere purposely discoursed; and therefore shall now proceed, and observe, in the second place, that, when we duly consider the very differing ends, to which many of God's particular works, especially those that are animated, seem designed, in reference both to their own welfare, and the utility of man; and with how much wisdom, and, I had almost said, care, the glorious Creator has been pleased to supply them with means admirably fit for the attainment of these respective ends; we cannot but think it highly probable, that so wise, and so benign a Being has not left his noblest visible creature, man, unfurnished with means to procure his own welfare, and obtain his true end, if he be not culpably wanting to himself. And since man is endowed with reason, which may convince him (of what neither a plant, nor brute animal is capable of knowing, namely) that God is both his maker, and his continual benefactor; since his reason likewise teacheth him, that upon both those accounts, besides others, God may justly expect and require worship and obedience from him; since also the same rational faculty may persuade him, that it may well become the majesty and wisdom of God, as the sovereign rector of the world, to give a law to man, who is a rational creature, capable of understanding and obeying it, and thereby glorifying the author of it; since (farthermore) finding in his own mind (if it be not depraved by vice, or lusts) a principle, that dictates to him, that he owes a veneration, and other suitable sentiments, to the divinely excellent author of his being, and his continual and munificent benefactor; since, on these scores, his conscience will convince him of his obligation to all the essential duties of natural religion; and since, lastly,

his reason may convince him, that his soul is immortal, and is therefore capable, as well as desirous, to be everlastingly happy, after it has left the body; he must in reason be strongly inclined to wish for a supernatural discovery of what God would have him believe and do. And therefore if, being thus prepared, he shall be very credibly informed, that God hath actually been pleased to discover by supernatural revelation (what, by reason, without it, he can either not at all, or but rovingly, guess at) what kind of worship and obedience will be most acceptable to him; and to encourage man to both these, by explicit promises of that felicity, that man, without them, can but faintly hope for; he would be ready then thankfully to acknowledge, that this way of proceeding befits the transcendent goodness of God, without derogating from his majesty and wisdom. And by these and the like reflections, whereof some were formerly intimated, a philosopher, that takes notice of the wonderful providence, that God descends to exercise for the welfare of inferior and irrational creatures, will have an advantage above men not versed in the works and course of nature, to believe, upon the historical and other proofs, that Christianity offers, that God has actually vouchsafed to man, his noblest, and only rational visible creature, an explicit and positive law, enforced by threatening severe penalties to the stubborn transgressors; and promising to the sincere obeyers rewards suitable to his own greatness and goodness. And thus the consideration of God's providence, in the conduct of things corporeal, may prove, to a well-disposed contemplator, a bridge, whereon he may pass from natural to revealed religion.

I HAVE been the more particular and express, in what I have said about divine providence, because I did not find other writers had made it needless for me to do so. And I dwelt the longer upon the existence of the Deity, and the immortality of the soul, that I might let you see, that I did not speak groundlessly, or rashly, but, that I had considered what I said, when I asserted, that the experimental philosophy might afford a well-disposed mind considerable helps to natural religion. I find myself therefore now at liberty to proceed to farther considerations, and represent to you, that,

V. ANOTHER thing, that disposes an experimentarian philosopher to embrace religion, is, that his genius and course of studies accustoms him to value and delight in abstracted truths; by which term, I here mean such truths, as do not at all, or do but very little, gratify mens ambition, sensuality, or other inferior passions and appetites. For, whereas the generality of those, that are averse from religion, are inclined to be so, upon this account (among others) that they have a contempt or undervaluation of all truths, that do not gratify their passions or interests; he, that is addicted to knowledge experimental, is accustomed both to pursue, esteem and relish many truths, that do not delight his senses, or gratify his passions, or his interests, but only entertain his understanding with that manly and spiritual satisfaction, that is naturally afforded it by the attainment of clear and noble truths, which are its genuine objects and delights. And though I grant, that the discoveries made by the help of physical or mechanical experiments are not, for the most part, of kin to religion; yet, besides that some of them do manifestly conduce to establish or illustrate natural theology, which is that (as, though noted already, deserves to be inculcated) which revealed religion, and consequently, that of Christians, must be founded on, or must suppose: besides this, I say, we may argue *à fortiori*, that he, that is accustomed to prize truths of an inferior kind, because they are truths, will be much more disposed to value divine truths, which are of a much higher and nobler order, and of an inestimable and eternal advantage.

VI. THERE is another thing, that is too pertinent to the main scope of this discourse to be here pretermitted: and it is, that both the temper of mind, that makes a man most

most proper to be a virtuoso, and the way of philosophising he chiefly employs, conduce much to give him a sufficient, and yet well grounded and duly limited docility, which is a great disposition to the entertainment of revealed religion. In the vulgar and superficial philosophy, wherein a man is allowed to think, that he has done his part well enough, when he has ascribed things to a substantial form, or to nature, or to some real quality, whether manifest or occult, without proving, that there are such causes, or intelligibly declaring, how they produce the phænomena, or effects referred to them; in this philosophy, I say, it is easy for a man to have a great opinion of his own knowledge, and be puffed up by it. But a virtuoso, that cannot satisfy himself, nor dares pretend to satisfy others, till he can by hypotheses, that may be understood and proved, declare intelligibly the manner of the operation of the causes he assigns, will often find it so difficult a task to do so, that he will easily discern, that he needs further information, and therefore ought to seek for it where it is the most likely to be had; and not only to admit, but welcome it if he finds it. Besides, the litigious philosophy of the schools seldom furnishes its disciples with better than dialectical or probable arguments, which are not proper, either fully to satisfy the person that employs them, or leave his adversary without any answer, plausible at least, if not full as probable as the objection, upon which account, men, that have more wit than sincere love of truth, will be able to dispute speciously enough, as long as they have a mind to do so. And as such slippery arguments are not able to convince even him that employs them, if he be a man of judgment; so if he deals with a witty adversary, they will leave him to elude any arguments of the like nature, with which he shall be pressed. And in effect we see, that in the Aristotelian philosophy there are divers questions, such as, whether the elements retain their distinct nature in a mixed body? Whether the celestial orbs are moved by intelligences? To omit many others, which are as it were stated questions; and as they have been disputed from age to age, are like to continue questions for many more, if that philosophy last so long. But a virtuoso, that is wont in his reasonings to attend to the principles of mathematics, and sound philosophy, and to the clear testimonies of sense, or well verified experiments, acquires a habit of discerning the cogency of an argument, or way of probation, and easily discerns, that dialectical subtilties and school tricks cannot shift off its force, but finds more satisfaction in embracing a demonstrated truth, than in the vain glory of disputing subtilly against it.

VII. ANOTHER thing, that may dispose a studious searcher of truth, (not by speculations only, but) by experiments, for theology, is, that his inquisitiveness, and course of studies, makes him both willing and fit to search out and discover deep and unobvious truths. I have with trouble observed, that the greater part of the libertines we have among us, being men of *Pilate's* humour, (who, when he had scornfully asked what is truth? would not stay for an answer) do with great fastidiousness decline the study of all truths, that require a serious and settled application of mind. These men are, for the most part, a sort of superficial and desultory wits, that go no further than the outside of things, without penetrating into the recesses of them; and being easily tired with contemplating one, pass quickly to another; the consideration whereof they with the same lightness forsake. And upon this account, among others, it is, that this sort of men, though often much applauded by others, because the most are but superficial, as well as they, do almost as seldom make good philosophers, as good Christians. For though all the good arguments, that may be brought to evince the truth of natural (and revealed) religion, be not abstruse; yet some of the chief ones, especially those, that prove the existence and special providence of God, and the soul's immortality, are, if not of a metaphysical, yet at least of a philosophical nature; and

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will scarce be clearly understood, and duly relished, but by a person capable of, and somewhat accustomed to attentive and lasting speculations, (as in another paper has been more fully declared.) But now, a man addicted to prosecute discoveries of truths, not only by serious meditation, but by intricate and laborious experiments, will not easily be deterred from effectually prosecuting his end, by the troublefomeness or difficulties that attend the clearing of those notions, and matters of fact, whereon solid arguments for natural or revealed religion are founded; how remote soever those truths may be from vulgar apprehensions. In short, whereas a superficial wit, such as is frequently found in libertines, and often helps to make them such, may be compared to an ordinary swimmer, who can reach but such things as float upon the water; an experimental philosopher may be compared to a skilful diver, that cannot only fetch those things, that lie upon the surface of the sea, but make his way to the very bottom of it, and thence fetch up pearls, corals, and other precious things, that in those depths lie concealed from other men's sight and reach.

WE have already seen, that experimental philosophy is, in its own nature, friendly to religion in general.

WHEREFORE I shall now add, that the reverence I pay experience, especially as it gives both grounds and hints to rational notions and conclusions, does not a little conduce to the assent I give to the truth of the Christian religion in particular.

THIS excellent religion is recommended to well-disposed minds by a greater number of prerogatives, and other arguments, than it were proper for me to insist on in this discourse: and yet my design engages me to consider a few of them somewhat particularly.

AND first, I shall observe, that whereas the three grand arguments, that jointly evince the truth of the Christian religion in general, are (at least in my opinion) the excellency of the doctrine, which makes it worthy to have proceeded from God; the testimony of the divine miracles, that were wrought to recommend it; the great effects produced in the world by it; two of these three arguments (for the first is of a more speculative nature) are bottomed upon matters of fact, and consequently are likely to be the most prevalent upon those, that have a great veneration for experience, and are duly disposed to frame such pious reflections, as it warrants and leads them to make. This last clause I add, because, though I have formerly more than intimated something of the like import, yet it is so necessary to my design, that you should take special notice of it, that I must not here omit to advertise you, that when, in this discourse, I speak of an experimental philosopher, or virtuoso; I do not mean, either on this hand, a libertine, though ingenious, or a sensualist, though curious; or on that hand, a mere empiric, or some vulgar chemist, that looks upon nothing as experimental, wherein chemistry, mechanics, &c. are not employed; and who too often makes experiments, without making reflection on them, as having it more in his aim to produce effects, than to discover truths. But the person I here mean, is such a one, as by attentively looking about him, gathers experience, not from his own trials alone, but from divers other matters of fact, which he heedfully observes, though he had no share in the effecting them; and on which he is disposed to make such reflections, as may (unforcedly) be applied to confirm and encrease in him the sentiments of natural religion, and facilitate his submission and adherence to the Christian religion.

AN experimental philosopher thus disposed, will, with the divine assistance, (which he will be careful to implore) find pregnant motives to the belief of Christianity, in the two last of the three arguments of its truth, that I lately proposed. That which is drawn from the effects of this religion in the world, as it is last named, so I shall defer

defer the consideration of it, till I have treated of the other, namely, the testimony of divine miracles, whose difficulty makes it requisite for us to consider it the more attentively, and distinctly declare the grounds, upon which experience may be esteemed a good topic on the present occasion. For the clearing of this matter, I shall represent to you, that the word experience may admit of divers senses, whereof one is far more comprehensive than another, and likewise of several divisions and distributions. For besides its more restrained acceptation, it is sometimes set in contradistinction to reason, so as to comprehend, not only those phænomena, that nature or art exhibits to our outward senses, but those things, that we perceive to pass within ourselves; and all those ways of information, whereby we attain any knowledge that we do not owe to abstracted reason. So that, without stretching the word to the utmost extent of which it is capable, and to which it has been enlarged; it may be looked upon as so comprehensive a term, that I think it may be of some importance to my present design, and perhaps to theology itself, to propose to you a distribution of experience, that will not, I hope, be found useless to clear the extent of that term. I shall then take the freedom to enlarge the signification of the word beyond its commonest limits, and divide it, for distinction's sake, into immediate and vicarious experience; or rather somewhat less compendiously, but perhaps more commodiously, into personal, historical, and supernatural, (which may be also stiled theological;) referring the first of the three members of this distribution to immediate experience, and the two others to vicarious.

I CALL that personal experience, which a man acquires immediately by himself, and accrues to him by his own sensations, or the exercise of his faculties, without the intervention of any external testimony. It is by this experience, that we know, that the sun is bright; fire hot; snow cold and white; that upon the want of aliments we feel hunger; that we hope for future goods; that we love what we judge good, and hate what we think evil; and discern, that there is a great difference between a triangle and a circle, and can distinguish them by it.

By historical experience I mean that, which, though it were personal in some other man, is but by his relation or testimony, whether immediately or mediately, conveyed to us. It is by this, that we know, that there were such men as *Julius Cæsar*, and *William the Conqueror*, and that *Joseph* knew that *Pharoah* had a dream, which the Egyptian wise men could not expound.

By theological experience I mean that, by which we know, what, supposing there is some divine revelation, God is pleased to relate or declare concerning himself, his attributes, his actions, his will, or his purposes, whether immediately, (or without the intervention of man) as he sometimes did to *Job* and *Moses*, and constantly to Christ our Saviour; or by the intervention of angels, prophets, apostles, or inspired persons, as he did to the Israelites, and the primitive Christian church; and does still to us, by those written testimonies we call the Scriptures.

By personal experience we know, that there are stars in heaven; by historical experience we know, that there was a new star seen by *Tycho* and other astronomers in *Cassiopea*, in the year 1572, and by theological experience we know, that the stars were made on the fourth day of the creation.

By this you may see, that I do not in this discourse take experience in the strictest sense of all, but in a greater latitude, for the knowledge we have of any matter of fact, which, without owing it to ratiocination, either we acquire by the immediate testimony of our own senses and other faculties, or accrues to us by the communicated testimony of others. And I make the less scruple to take this liberty, because I observe, that even in common acceptation, the word experience is not always meant of that

that which is immediate, but is often taken in a latitude. As when we say, that experience teaches us, who perhaps were never out of *England*, that the torrid zone is habitable and inhabited; and persuades learned men, that never had opportunity to make nice celestial observations, that stars may be generated and perish, or at least begin to appear, and then disappear in the celestial region of the world. And on this kind of historical experience, consisting of the personal observations of *Hippocrates*, *Galen*, and other physicians, transmitted to us, a great part of the practice of physic is founded. And the most rational physicians reckon upon, as matters of fact, not only what other physicians have left upon record, but divers present things, which themselves can know but by the relation of their patients; as that a man has a particular antipathy to such a thing, which the doctor perhaps judges fit for him to use; or that a woman with child longs for this or that determinate thing. And physicians reduce these and the like matters of fact to experience, as to one of the two columns of physic distinguished from reason.

SINCE then learned men, as well as common use, confine not the appearance of the word experience to that which is personal, but employ it in a far greater latitude, I see not, why that, which I call theological experience, may not be admitted; since the revelations, that God makes concerning what he has done, or purposes to do, are but testimonies of things, most of them matters of fact, and all of them such, as so far forth as they are merely revelations, cannot be known by reasoning, but by testimony: whose being divine, and relating to theological subjects, does not alter its nature, though it give it a peculiar and supereminent authority.

HAVING premised and cleared the proposed distribution of experience, it will now be seasonable to consider, how it may be applied to the matters of fact, that recommend the credibility of the Christian religion; and on this occasion I shall distinctly offer you my thoughts in the two following propositions.

PROP. I. "We ought to believe divers things upon the information of experience, (whether immediate, or vicarious) which, without that information, we should judge unfit to be believed, or antecedently to it did actually judge contrary to reason."

THIS proposition may be understood, either of persons, or of things, and will hold true as to both.

AND first, as to persons; if your own observation of what occurs among mankind do not satisfy you, that we are obliged, after sufficient trial, frequently to alter the opinions, which upon probable reasons we had before entertained, of the fidelity, or prudence, or justice, or chastity, &c. of this or that person; I shall refer you to the records of history, or appeal to the tribunals of judges. For both in the one, and at the other, you will find but too many instances and proofs from matters of fact, that persons looked on, even by intelligent men, as honest, virtuous, and perhaps holy too, have proved guilty of falseness to their friends, perfidiousness to their princes, disloyalty to their husbands or wives, injustice to their neighbours, sacrilege, perjury, or other impieties to their God: and in the courts of justice, you will find a great part of the time employed to detect and punish, not only civil transgressions, as thefts, cheats, forgery, false-witness, adultery, and the like heinous crimes, perpetrated by those, that before they were thoroughly sifted, passed for honest; but you will find sins against nature, such as sodomy, and other unnatural lusts, the murders of parents by their children, and innocent children by their parents, nay, self-murder too; though this be a crime, which cannot be acted without a violation of what seems the most universal and radicated law of nature, (and is acknowledged so by wicked

wicked men) self-preservation. But it will not be necessary more solicitously to prove, that we ought, upon the testimony of experience, to change the opinions we thought we had rationally taken up of persons; and therefore I shall now proceed to make good the proposition in the sense I chiefly intended, which is as it relates to things.

If experience did not both inform and certify us, who would believe, that a light black powder should be able, being duly managed, to throw down stone walls, and blow up whole castles and rocks themselves, and do those other stupendous things, that we see actually performed by gun-powder, made use of in ordnance, and in mines? Who would think, that two or three grains of opium should so stupify a whole body, as to force a sleep, and oftentimes even without that suspend the sharpest torments in the cholic, gout, and other the most painful diseases, and that in patients of quite different ages, sexes, and constitutions, in whom also the diseases are produced by differing, or even by contrary causes? Who would believe, that the poison, adhering to the tooth of a mad dog, though perhaps so little as to be scarce discernable by sense, should be able, after the slight hurt is quite healed, to continue in the warm and still perspirable body of the bitten person, not only for some days or months, but sometimes for very many years? And after having lurked all that while, without giving any trouble to the patient, should on a sudden pervert the whole oeconomy of his body, and put him into a madness like that of the dog that bit him, discovering itself by that as admirable as fatal symptom of hydrophobia.

BUT, besides a multitude of instances, that may be given of truths, that, were it not for experience, we should refuse to believe; because the small strength of such agents seems altogether disproportionate to the effects ascribed to them; many other instances might be alledged, wherein we assent to experience, even when its informations seem contrary to reason, and that which, perhaps, we did actually and without scruple take to be true.

SINCE gravity is the principle, that determines falling bodies to move towards the center of the earth; it seems very rational to believe, with the generality of philosophers, that therein follow *Aristotle*, that, in proportion as one body is more heavy than another, so it shall fall to the ground faster than the other. Whence it has been, especially by some of the peripatetic school, inferred, that of two homogeneous bodies, whereof one does, for example, weigh ten pounds, and the other but one pound, the former being let fall from the same height, and at the same time, with the latter, will reach the ground ten times sooner.

BUT notwithstanding this plausible ratiocination, experience shews us (and I have purposely tried it) that (at least in moderate heights, such as those of our towers, and other elevated buildings) bodies of very unequal weight, let fall together, will reach the ground at the same time, or so near it, that it is not easy to perceive any difference in the velocity of their descent.

It is generally taken for granted by naturalists, as well as others, that strong and loud noises, as they are heard much farther off than fainter sounds, so, if the sonorous bodies be equally distant from the ear, the very strong sound will arrive much sooner at it, than the other. And yet by the experiments of the moderns about the velocity of sounds (in making divers of which, I have endeavoured to be accurate) it appears, that weaker sounds are (at least as to sense) transmitted through the air as swiftly as stronger ones. And indeed; it is often observed, that when cannons and muskets are discharged together, the noises of both arrive also together at the ear; which would not be, if the sound of a cannon were any thing near as much swifter, as it is louder, than that of a musket.

It

It seems irrational to conceive, that a smaller and weaker loadstone may draw away a piece of steel from a larger and stronger; and yet experience (which both others and I have made) evinces, that in some cases this paradox is a truth.

It has generally, by philosophers as well as other men, been looked upon as manifest, and consonant to reason, that cold condenses water more or less, according as the degree of the cold is; and consequently that ice is water reduced into a lesser volume. But it is plain, by experiments carefully made (some of which I have elsewhere published) that by glaciation, water is rather expanded; or at least, that ice takes up more room, than the water did before it was congealed. And of this sort of instances, where we believe, upon the authority of experience, things, that are contrary to what we should otherwise judge to be a dictate or conclusion of reason; I could add many, if I thought it as needful in this place, as in some other papers, where I have given them already.

An essay
of impro-
bable
truths.

AND now it will be seasonable to put you in mind, that in one part of the proposition, hitherto discoursed of, it appears, that I designed to extend the force of the arguments, grounded upon experience, to that, which is not immediate, but vicarious; that is, not personally our own, but communicated by others; provided it be competently attested, and duly conveyed to us.

THERE will need but a little reflection on what is judged reasonable, and freely practised, by philosophers themselves, to justify this proposition. For how many conclusions have the modern naturalists admitted, though not only abstracted reason never led men to make them, but plausible arguments, and the notions and axioms of the most generally received philosophy were repugnant to them. Thus, that in heaven itself there should be generations and corruptions, was not only unobserved before the time of *Aristotle* (who thence argues the incorruptibility of celestial bodies) but is contradicted by his arguments; and yet both many others, and I, have seen great spots (perhaps bigger than *England*, or than *Europe* itself) generated and dissipated on or near the surface of the sun; and several of the modern philosophers and astronomers, having never had the good fortune to see any of these (which indeed of late years have but rarely appeared) must take these phænomena upon the credit of those that have observed them. And much more must they do so, who, in spite of the vulgar philosophy, which made all comets sublunary, believe, there were celestial, and perhaps firmamentary, comets. For, that they were above the concave of the moon's orb, we must believe upon the affirmation of those that observed them, which very few have done themselves. And the height of the famous comet, or disappearing star, in *Cassiopea*, in the year 1572, whereon so much stress is laid by our philosophers and mathematicians, is admitted and urged, chiefly upon the belief they have, not only of *Tycho*'s veracity, but his skill in observing the motions and phænomena of that celestial light, and particularly its having no parallax.

IN short, the great architect of experimental history, Sir *Francis Bacon*, when he divides it but into three parts, assigns the second of them to what he calls præter-generations, such as monsters, prodigies, and other things; which being (as to us) but casualties, all those that happened in other times and places than we have lived in (and those will be confessed to be incomparably more than any of us has personally observed) we must take upon the credit of others. And yet these (vicarious experiments) by suggesting new instances of nature's power, and uncommon ways of working; and by overthrowing, or limiting, received rules and traditions, afford us a considerable and instructive part of natural history, without which, it would not be either so sound, or so compleat.

PROP. II. After what has been hitherto discoursed, it may be, I hope, both seasonable and warrantable to advance to, and assert, our second proposition; *viz.* That "we ought to have a great and particular regard to those things, that are recommended to our belief, by what we have reduced to real, though supernatural, experience."

FOR, 1. It is manifest, that the most rational men scruple not to believe, upon competent testimony, many things, whose truth did no way appear to them by the consideration of the nature of the things themselves; nay, though what is thus believed upon testimony be so strange, and, setting aside that testimony, would seem so irrational, that, antecedently to that testimony, the things at last admitted as truths were actually rejected as errors, or judged altogether unfit to be believed. And I must here desire you to consider, that the points, wherein experience over-rules that, which, before it supervened, was judged to be most agreeable to reason, concerning things merely natural or civil, whereof human reason is held to be a proper judge: whereas many of the points recommended by supernatural experience concern things of a superior order; many of which are not to be adequately estimated by the same rules with things merely corporeal or civil; and some of which, as the essence and manner of existence, and some peculiar attributes, of the infinite God, involve or require such a knowledge of what is infinite, as much passes the reach of our limited intellects.

BUT this is not all. FOR, 2. You may consider in the next place, that, whereas it is as justly as generally granted, that the better qualified a witness is in the capacity of a witness, the stronger assent his testimony deserves; we ought, of all the things that can be recommended to us by testimony, to receive those with the highest degree of assent, that are taught us by God, by the intervention of those persons, that appear to have been commissioned by him to declare his mind to men. For the two grand requisites of a witness, being the knowledge he has of the things he delivers, and his faithfulness in truly delivering what he knows; all human testimony must on these accounts be inferior to divine testimony: since this (latter) is warranted both by the veracity of God (which is generally acknowledged by those that believe his existence) and by his boundless knowledge; which makes it as impossible He should be deceived Himself, as the other does, that He should deceive us. And, because that, for the delivery of the divine testimony we are speaking of, it has oftentimes pleased God, who is a most free (as well as a most wise) Agent, to make use of unpromising persons as his instruments; I shall not on this occasion altogether overlook this circumstance, that an experimental philosopher so often increases his knowledge of natural things, by what he learns from the observations and practices, even of mean (and perhaps of illiterate) persons (such as shepherds, plowmen, smiths, fowlers, &c.) because they are conversant with the works of nature; that he is not only willing to admit, but often curious to seek for, informations from them; and therefore is not like to find much repugnancy in receiving the doctrines of revealed religion, such as Christianity, if the teachers of it were honest men, and had opportunity to know the truth of the things they deliver, though they were fishermen, tent-makers, or some other mean profession.

AND indeed (to enlarge a little upon a subject, that, I fear, has scarce been considered) such a person as our virtuoso will, with both great willingness and no less advantage, exercise himself in perusing, with great attention and much regard, the writings of the apostles, evangelists, and ancient prophets; notwithstanding any meanness of their first condition, or of their secular employments. And, in these sacred

writings, he will not only readily suffer himself to be instructed in these grand and catholic articles of religion, which, because of their necessity or very great usefulness, are to be met with in many places, and in variety of expressions, by honest and duly disposed readers; but he will, instead of disdaining such tutors, both expect, and carefully strive, to improve his knowledge of divine things in general, even by those hints and incidental passages, that a careless or ordinary reader would overlook, or not expect any thing from. For, as the fecundity of the scriptures is not wont to be enough discerned, when the sacred writers transiently touch upon, or glance at, a great many subjects, that they do not expressly handle, and that therefore are not vulgarly taken notice of; so the docility we have ascribed to our virtuoso will make him repose a great deal of trust in the testimony of inspired persons, such as Christ and his apostles, about things of all sorts, either usually taken notice of or not, that relate to objects of a supernatural order; especially if among these God Himself, and his purposes, be comprised, since divers of those things are not knowable without revelation, and others are best known by it. And to be allowed to ground a belief about such things on the relations and other testimonies of those that were, in the

Luke i. 2. scripture-phrase, "eye-witnesses and ministers" of the things they speak of, will by our virtuoso be justly reputed such an advantage, in order to the knowledge of things divine, as the consulting with navigators and travellers to *America* is to him, that is curious to learn the state of that new world. For an ordinary seaman or traveller, that had the opportunity with *Columbus* to sail along the several coasts of it, and pass up and down through the country, was able at his return to inform men of an hundred things, that they should never have learned by *Aristotle's* philosophy, or *Ptolemy's* geography; and might not only acquaint them with divers particulars, consonant to the opinions, which their formerly received physics and cosmography did suggest, but also rectify divers erroneous presumptions and mistakes, which till then they thought very agreeable to the dictates of those sciences, and so to reason. And as one, that had a candid and knowing friend intimate with *Columbus*, might better rely on his informations about many particulars of the natural history of those parts, than on those of an hundred school-philosophers, that knew but what they learned from *Aristotle*, *Pliny*, *Ælian*, and the like ancient naturalists; so, and much more, may we rely on the accounts given us of theological things, by the apostles, and constant attendants

John i. 18. of Him that lay in the "bosom of God his Father," and commissioned them to
Acts xx. declare to the world "the whole counsel of God," as far as it was necessary for man
27. to know.

We know, that fuller trials are allowed among ingenious men, to rectify the informations of the more imperfect ones; and therefore I shall add, that though the innate notions and sentiments, that nature gives us of the attributes and mind of God, be highly to be prized; yet the informations, that theological experience affords of those abstruse things, is far more excellent and compleat. For methinks, those great

1 Cor. ii. 10. "depths of God" may be compared to the depths of the ocean. And we know, that in the sea, there are some abysses so deep, that the seaman's sounding-lines have never been able to reach to the bottom of them; and where they are not unfathomable, all we are wont to do, by our soundings, is, to fetch from the bottom some little gravel, or mud, or shells, or some such thing, that flicks to the tallowed end of the plummet, and gives us but a very imperfect account of the bottom, even of the shallower parts of the sea: but, if a skilful diver be employed, he will not only tell us, whether the bottom be muddy, gravelly, or sandy, but will be able to give us a kind of topography of that submarine land, and acquaint us with many surprising particulars, that we should never otherwise have discovered, or perchance so much.

much as dreamed of. And peradventure it may be no hyperbole to say, that the informations of a plummet, which reaches not to some depths, and brings but a very slender account of soils that lie in any, are not more short of those of a diver, than the informations philosophy gives us of some divine things are of those compleater ones, that may be had from the holy Scriptures. And when I remember, how many opinions about the submarine parts, that I, among many other men, thought probable, I found cause to change, upon the conversation I had with a famous diver, that sometimes, by the help of an engine, staid several hours at the bottom of the sea; I find the less reluctancy to suffer opinions about divine matters, that before seemed probable to me, to be rectified by the fuller discoveries made of those things by the preachers of the gospel.

You may find some things applicable to the confirmation of what has been newly delivered in an essay, (which you may see when you please) that considers the bounds and use of experience in natural philosophy. Wherefore remembring, that before this late excursion I was speaking of miracles, I shall now resume the subject, and proceed to tell you, that I have the more insisted upon the miracles, that may be pleaded to recommend the Christian religion, because I thought, that an argument grounded on them is little less than absolutely necessary, to evince, that any religion, that men believe to be supernaturally revealed, and consequently that the Christian, does really proceed from God.

FOR, though the excellency of the Christian doctrine, and other concurrent motives, may justly persuade me, that it is worthy, and likely to be given by God; yet that *de facto* this doctrine comes from Him by way of supernatural revelation, I can scarce be sufficiently ascertained, but by the miracles wrought by Christ and his disciples, to evince, that the doctrine they preached, as commissioned by God to do so, was indeed his, being as such owned by Him. But these miracles having been wrought (when it was most fit and needful they should be wrought) in the first ages of the church, we, that live at so great a distance from them, can have no knowledge of them by our own senses, or immediate observation; but must believe them upon the account of the formerly mentioned historical or vicarious experience, which is afforded us by the duly transmitted testimony of those, that were themselves (to speak once more in an evangelist's phrase) "eye-witnesses and ministers" of the things they relate. And since we scruple not to believe such strange prodigies, as celestial comets, vanishing and re-appearing stars, islands founded by subterranean fires in the sea, darkenings of the sun for many months together, earthquakes reaching above a thousand miles in length, and the like amazing anomalies of nature, upon the credit of human histories; I see not, why that vicarious experience should not more be trusted, which has divers peculiar and concurrent circumstances to confirm it, and particularly the death, that most of the first promulgators chearfully suffered to attest the truth of it, and the success and spreading of the doctrine authorized by those miracles, and received chiefly upon their account. To which things some perhaps would add, that it is less credible, that the Author of nature should, for most weighty purposes, make stupendous alterations of the course of nature, than that nature herself, for no such end, should by such prodigies, as are newly mentioned, as it were, throw herself out of her own course. Luke i. 2.

MIRACLES being so necessary to the establishment of revealed religion in general, it may be looked upon as a farther disposition in our virtuoso, to receive the Christian religion, that the philosophy, he cultivates, does much conduce to enable him to judge aright of those strange things, that are by many proposed as miracles, and believed to be so.

For first, the knowledge he has of the various (and sometimes very wonderful) operation of some natural things, especially when they are skilfully improved, and dexterously applied by art, particularly mathematics, mechanics, and chemistry, will qualify him to distinguish between things, that are only strange and surprising, and those that are only miraculous; so that he will not mistake the effects of natural magic, for those of a divine power. And by this well-instructed wariness, he will be able to discover the subtil cheats and collusions of impostors; by which, not only multitudes of all religions, especially heathen, but even learned men of most religions, for want of an insight into real philosophy, have formerly been, or are at this day, deluded, and drawn into idolatrous, superstitious, or otherwise erroneous tenents or practices.

AND on the other side, the knowledge our virtuoso may have of what cannot be justly expected or pretended from the mechanical powers of matter, will enable him to discern, that divers things are not produceable by them, without the intervention of an intelligent superior power; on which score he will frankly acknowledge, and heartily believe, divers effects to be truly miraculous, that may be plausibly enough ascribed to other causes in the vulgar philosophy; where men are taught and wont to attribute stupendous unaccountable effects to sympathy, antipathy, *fuga vacui*, substantial forms, and especially to a certain being, presumed to be almost infinitely potent and wise, which they call nature: for this is represented as a kind of goddess, whose power may be little less than boundless; as I remember *Galen* himself compares it to that of God, and saith, that He could not do such a thing, because nature cannot; and censures *Moses* for speaking as if he were of another mind. The whole passage is so weighty, that I thought to direct you to it in the margin; though, to comply with my haste, I forbear to describe and descant upon so prolix a one, and add to it divers other passages, that I have met with in famous authors; who, for want of knowing the true extent of the powers of matter and motion, left to themselves in the ordinary course of things, ascribe to natural causes, as they call them, such effects as are beyond their reach, unless they be elevated by agents of a superior order.

*Galen, de
Usu part.
Lib. 11.
Cap. 14.*

I know it may be objected, that the hitherto-mentioned dispositions, that experimental knowledge may give a man to admit the histories of the miracles recorded in the gospel; and likewise to expect, that God will be able to perform the promises and menaces that are in his name delivered there, may be countervailed by this, that those, who are so much acquainted with the mysteries of nature, and her various and strange ways of working, as a virtuoso may well be, may by that knowledge be strongly tempted to think, that those surprising things, that other men call miracles, are but effects of her power; the extent of which is not easily discerned by ordinary men, nor safely defined by philosophers themselves. But this objection being plausible enough, to make me think it deserved to be seriously considered, I took an occasion, that was once offered me, to examine the validity of it in a paper by itself; and this being at your command, I shall refer you to it. And I hope, that in the mean time it may suffice to say, that to make it reasonable to judge this or that particular performance a supernatural one, it is not at all necessary, that it surpass the whole power of nature, that is, of physical agents, provided it surpass the power of that cause, or that complex of causes, from which the effect must in reason, if it be purely natural or physical, be supposed to have proceeded. As for instance, that a fisherman or two should speak other languages than their own, does not at all exceed the power of nature, if they employed a competent time in learning them. But that a great number of fishermen, and other illiterate persons, should all on a

sudden become linguists, and in an hour's time be able to speak intelligibly to a great number and variety of nations in their respective languages, as the new testament relates, that the apostles and their companions did on the day of pentecost: that gift See Acts iii. of tongues, I say, was an ability, which, in those circumstances of place, time, and persons, wherein it was exercised, may justly be concluded to have been supernatural or miraculous.

I FEAR you will think I have dwelt too long upon the argument for Christianity, drawn from that sort of matter of fact we call miracles; though the uncommon way, that my design led me to represent them in, would not permit me to make it out in fewer words. Wherefore I shall now pass on to another argument, in favour of the same religion, that is afforded by experience, being drawn from the strangely successful propagation, and the happy effects, of Christianity in the world. But having formerly had occasion to display this argument in a separate paper, which you may command a sight of, if I shall not have time to annex a transcript of it to the latter sheets of this first part of the present essay, I will refer you for more ample proof to that writing, and content myself in this place briefly to touch some of the heads, and subjoin a reflection or two, that you will not meet with in that paper.

It is a notorious matter of fact, that, in less than half an age, the Christian religion was spread over a great part of the then known world; inasmuch that, in a few years after it began to be preached, the apostle of the Gentiles could tell the Romans with joy, that their faith (*i. e.* profession of the gospel) “was spoken of throughout Rom. i. 8. the whole world.” And in the second century, *Tertullian*, and other famous writers, shew, that the gospel had already numerous proselytes in a great number of different kingdoms and provinces. But I forbear to mention what he and others have magnificently said of the success of the gospel, because I had rather refer you to the plain narratives made of it by *Eusebius*, *Socrates Scholasticus*, and other grave authors; being of opinion, that mere historians may give, to a philosophical reader, a more advantageous idea of the efficacy of that excellent doctrine, than eloquent orators, as such, can do. The wonderful quick progress of this religion being ascertained to our virtuoso, by a thing he is so much swayed by as experience; it does not a little dispose him to believe the truth of so prevalent a religion. For, if he considers the persons, that first promulgated it, they were but half a score of illiterate fishermen, and a few tent-makers and other tradesmen. If he considers the means, that were employed to propagate this doctrine, he finds, that they had neither arms, nor external power, to compel men to receive it; nor riches, honours, or preferments, to bribe or allure them to it; nor were they men of philosophical subtilty, to entrap or entangle the minds of their auditors. Nor did they make use of the pompous ornaments of rhetoric, and fetches of oratory, to inveigle or entice men; but treated of the most sublime and abstruse matters, in a most plain and unaffected style, as became lovers and teachers of truth. If he considers the nature of the doctrine, that in little time obtained so many proselytes, he will find, that (instead of being suited to the natural apprehensions or the received opinions of men; and instead of gratifying their corrupt affections, or complying with so much as their innocentest interests) it prescribed such mortifications, and such great strictness of life, and high degrees of virtue, as no legislator had ever dared to impose upon his subjects, nay, nor any philosopher on his disciples. And this doctrine was proposed in such a way, and was accompanied with predictions of such hardships and persecutions, that should in those times be the portion of its sincere professors, as if the Law-giver had designed rather to fright men from his doctrine, than allure them to it; since they could not believe what He said, and foretold, to be true, without believing, that they should be

be made great sufferers by that belief. If our virtuoso considers the opposition made to the progress of the gospel, he will find cause to wonder, that it could ever be surmounted. For the heathens, which made by far the greatest part of the world, were deeply engaged in polytheism, idolatry, magical rites and superstitions, and almost all kind of crimes, and some of these were shameless debaucheries, which oftentimes made a part of their worship. And the Jews were by the corrupt leaven of the Pharisees, and the impious errors of the Sadducees, and the general mistakes of the nation about the person, office, and kingdom, of the *Messias*; and by their dotage upon their vain traditions, and numerous superstitions grounded upon them: the Gentiles, I say, and the Jews, who were those, that were to be converted, were, on these and other accounts, highly indisposed to be made proselytes. Especially when they could not own themselves to be such, without exposing their persons to be hated and despised, their possessions to be confiscated, their bodies to be imprisoned and tormented, and oftentimes their lives to be in as ignominious as cruel ways destroyed. And whilst the secular magistrates made them suffer all these mischiefs, the venerated priests, the subtil philosophers, and the eloquent orators, persuaded the world, that they deserved yet more than they endured, and employed all their learning and wit to make the religion odious and ridiculous, as well as the embracers of it miserable: accusing the martyrs, and other Christians, of no less than atheism, incest, and the inhuman shedding and drinking the innocent blood of infants. These and the like matters of fact when our virtuoso reflects on, and considers by what unpromising means (as far as they were but secular) such seemingly insurmountable difficulties were conquered; he cannot but by this historical experience be inclined to think, that effects, so disproportionate to the visible means, could not be brought to pass without the peculiar assistance and extraordinary blessing of God: by whom those successful preachers averred themselves to be commissioned. For, that the supernatural help, the Christian doctrine appears to have had, was divine, not diabolical, will seem evident to our virtuoso, from the nature, tendency, and effects of the doctrine itself, which expressly teacheth, that there is but one God; that He alone is to be worshipped, and not idols, nor any of the heathen dæmons or deities; that the devils are wicked, apostate, malicious, and miserable creatures, that are hated of God, and do extremely hate mankind; and that those vices, as well as rites of worship, that they have established in the world, were abominable to God, and would be by degrees destroyed by Him: as in effect they soon began to be in many places of the world, where the worshippers of Christ cast the devil out of his temples, out of men's veneration, and oftentimes out of their bodies too.

ONE circumstance there is of the propagation of the gospel, which, though it may seem more extrinsecal than those hitherto mentioned, is yet too considerable to be here pretermitted; since it is this, that the quick spreading and success of the Christian doctrine in the world was foretold both by the prophets of the old testament, and the Author and promulgators of the new. For it being notorious, that there have been divers errors and superstitions, that have with too much celerity been spread far and wide in the world, either by mere accidents, (as they were reputed) that were very friendly to them, or by the industry and artifices of men: this, I say, being so, it ought to be no small satisfaction to equitable judges, that the quick progress and notable effects of the Christian religion were foretold, partly by the ancient prophets, and partly by the *Messias* and his apostles. For by these accomplished predictions it may appear, that the wonderful success of the gospel was not an effect of chance, but was long before determined by divine providence, as a work fit to be dear to God, and to be accomplished in a wonderful way by his peculiar assistance,

(as will by and by be somewhat more fully declared). That the triumphs of the gospel were foretold by several of the old prophets, may appear by their yet extant writings; some of which are alledged to that purpose by those writers of the new testament, that were endowed with the same prophetic spirit. And if you please to consider the passages cited in the margin, you will easily grant, that those ancient inspired writers foresaw, that, in the days of the Messias, there should be a great and notable conversion of the Gentiles, of several nations, to the worship of the only true God of Israel: and though God did not think fit, that those predictions extant in the gospel should be so conspicuous and pompously set forth, that speak of the conversion, that should be made, not only of the heathen world, but (of a more refractory portion of mankind) a great part of the Jewish nation, to the Christian doctrine; yet there are divers passages in the new testament, that are real, though some of them unheeded, prophecies of the wonderful progress of the gospel, and the large extent of the kingdom of the Messias. Thus Christ foretold, that his twelve apostles should be his witnesses, not only in *Judea* and *Samaria*, but to the uttermost parts of the earth. And according to the most probable explication of that text, in the xxivth of St. *Matthew's* gospel, which is usually referred to the end of the world, but seems rather to respect the destruction of *Jerusalem*; there is a prediction, that before "the end (of the Jewish polity, as well as the Mosaicæ œconomy) the gospel of the kingdom (of the Messias) should be preached or proclaimed in the whole world," (in that sense of the term world, that was then much in use, and was employed by the evangelist *Luke* to signify the Roman world or empire.) To which may be added, that ten or twelve fishermen (called the apostles) were sent to convert all nations to the worship of a crucified Person; which would have been a strange commission to be given such men at that time, if their Master, who sent them, had not foreseen the success, as well as known the truth, of the doctrine He sent them to preach. The quick diffusion of the Christian faith, and the swift growth of the Christian church from despicable beginnings to a greatness very disproportionate to them, are more than intimated by what Christ says of the leaven hid in a great quantity of meal; and of the mustard-seed, that quickly grows (in the hot and fertile country of *Judea*) to a wonderful bigness and height; since these passages, that perfunctory readers look on but as mere parables, were really prophecies, that quickly began to be manifestly fulfilled. And it may bring no small authority to the predictions of the new testament, that, when divers of them were made, there appeared no likelihood, that they should ever be made good. When a poor virgin, that was betrothed to a carpenter, confidently pronounces, that *all ages should call her blessed*; what probability was there, that what she said should come to pass? And when another private woman, then living in a village, had it foretold her, that a censured action of hers should be reported through the whole world, to her great praise; what sober man, that were not a prophet, would venture to lose his credit, by making such a promise? And therefore, since we see such unlikely predictions actually accomplished, it may well convince an unbiassed man, that the authors of them, as well as the ancient seers, were really endowed with a truly prophetic spirit; and that the events, by that foretold, were not effects of chance or policy, but of divine providence.

I THOUGHT it not improper to make the mention of these predictions follow so close the discourse of the miracles, because true prophecies of unlikely events, fulfilled by unlikely means, are supernatural things; and as such (especially their Author and design considered) may properly enough be reckoned among miracles. And I may add, that these have a peculiar advantage above most other miracles, on the score of their

Gen. xlix.
Isa. ii. 2.
Ps. ii. 8.
Mal. i. 11.

Mat. xxiv.
14.
Παρά τῆς
ἐκκλήσιας.
Luke ii. 10.

Mat. xxvi.
13.

their duration: since the manifest proofs of the prediction continue still, and are as visible as the extent of the Christian religion; and some of them are still more and more accomplished by the conversions made of multitudes of infidels, in several vast regions of *America*, (to name no other countries). So that if we may call some miracles transient ones, such as the turning water into wine at a wedding-feast in *Galilee*; and the darkening of the sun, when the moon was full, at the crucifixion of Christ: accomplished predictions may be stiled permanent ones; and their difference may be set forth by the differing states of the Mosaic manna: for, though both that, which fell daily (except on the sabbath) in the wilderness, and that which was laid up in a pot before the testimony, were supernatural productions; yet, whereas a portion of the former outlasted not two or three days, that kept in the pot was preserved many ages, and continued to be (as it was foretold it should) a visible miracle.

Exod. xvi.
14, 21, 26,
33.

THERE is another reason, why the wonderful propagation of the gospel should be annexed to the argument drawn from miracles in favour of the Christian religion. For the preachers of it both pretended and appealed to miracles, as proofs of the truth of their doctrine: and (if we consider the great disadvantages they lay under, and the powerful opposition of all sorts, that they met with and surmounted) it cannot reasonably be thought, that such unlikely men should so successfully preach so uninviting a doctrine, unless it were confirmed by conspicuous miracles: or, at least, if so uneasy and persecuted a religion was propagated without miracles, that propagation itself (as one of the fathers well observes) may justly pass for a miracle; and be no less fit than another, to confirm the religion so admirably propagated.

THE past discourse has, I hope, manifested, that a virtuoso has some helps, that other men generally speaking have not, to make him judiciously approve the arguments for the truth of the Christian religion, that are grounded on the miracles wrought in its favour, and the wonderful success of it in the world. But because a revealed religion, how true soever it be, can scarce be proved but by moral demonstrations; and because, for this reason, it is not always sufficient, that the arguments be good in their kind, but there are some qualifications required in the minds of them that are to be convinced by him; I shall now add, that experimental philosophy does also dispose the minds of its cultivators to receive due impressions from such proofs, as miracles do, as well as other topics, afford the Christian religion.

ANOTHER thing then, that qualifies an experimentarian for the reception of a revealed religion, and so of Christianity, is, that an accustomance of endeavouring to give clear explications of the phænomena of nature, and discover the weakness of those solutions, that superficial wits are wont to make and acquiesce in, does insensibly work in him a great and ingenuous modesty of mind. And on the score of this intellectual (as well as moral) virtue, not only he will be very inclinable, both to desire and admit further information, about things which he perceives to be dark or abstruse; but he will be very unapt to take, for the adequate standard of truth, a thing so imperfectly informed, and narrowly limited, as his mere or abstracted reason, (as I think I have elsewhere intimated, that one may call that, which is furnished only with its own, either congenite, or very easily and very early acquired notions and ideas, and with popular notices). And though a vulgar philosopher, that allows himself to refer the obscurest things in nature to substantial forms, real qualities, sympathy, antipathy, and some few other terms, which, to be employed by him, need not, and perhaps for their darkness cannot, be clearly understood; and by which he pretends to explain all things in nature, and may indeed explicate one thing as well as another; though (I say) such a titular philosopher may presume, that he understands every thing, and may be easily tempted to think, that he must not hope, nor desire, to learn from

from less able men than his first teachers; and that, that cannot be true, or be done, which agrees not with his philosophy; yet a sober and experienced naturalist, that knows what difficulties remain yet unsurmounted in the presumed clear conception and explications even of things corporeal, will not, by a lazy or arrogant presumption, that his knowledge about things supernatural is already sufficient, be induced to reject, or to neglect any information, that may encrease it.

AND this frame of mind is a very happy one for a student in revealed theology, where cautiousness is not more necessary for the avoiding of errors, than docility is advantageous for the learning of truth: since the knowledge and goodness of the divine teacher is such, that a scholar, to improve his intellect, needs but bring a mind fitted to receive the genuine informations, that are most liberally offered (in the Scripture) and will never deceive him; that employs, together with fervent prayers, a due care not to mistake the meaning of them.

AN assiduous conversation with the exquisitely framed, and admirably managed works of God, brings a skilful considerer of them to discover, from time to time, so many things to be feasible, or to be true, which, whilst he argued but upon grounds of incompetently informed reason, he judged false or unpracticable; that little by little he acquires a habit of receiving some sorts of opinions, and especially those that seem unfriendly to religion, but as probationers, with a disposition to reform or discard them upon further information. And this as he is resolved to submit to, in case he meets with it, so he is disposed to receive, if not to expect it, by having often found himself obliged, upon subsequent information, to mend or lay aside his former opinions, though very agreeable to the best light he had to judge by, when he entertained them. As though it seems a visible truth, that the discus of *Venus* is, in all respects to the sun, totally luminous; yet when the telescope discovers her to have her full and her wane, like the moon, he will believe this further observation against the first made with his naked eyes.

AND indeed, I have sometimes doubted, whether to be versed in mathematics, and other demonstrative parts of philosophy, bring a greater advantage to the mind, by accustoming and assisting it to examine strictly things proposed for truths, and to evince strongly the truths a man knows to others, than by fitting him to discern the force of a good argument, and submit willingly to truths clearly evinced, how little soever he may have expected to find such conclusions true. It will not be difficult to apply these reflections to our present purpose, since there are several passages in the Scripture, that sufficiently declare, both that multitudes persist in a criminal infidelity, out of an over-weening conceit of their own knowledge, and a readiness to be swayed rather by strong prejudices, than by the strongest arguments that would remove them; and that docility is a very happy disposition to the entertainment of revealed religion: in reference to which, this qualification will be the more easily found in our virtuoso; because, whereas the things, about which he has been accustomed to be sensible of his ignorance, or desire further instruction, are within the sphere of nature, and the jurisdiction of philosophy; many of the things that revealed religion declares, (such as are the decrees, the purposes, the promises, &c. of God, and his most peculiar manner of existing and operating) are things so sublime and abstruse, that they may well be looked upon as of an higher order than merely physical ones, and cannot be satisfactorily reached by the mere light of nature. It is true, that our philosopher, because he is so, will examine more strictly, than ordinary men are wont or able to do, the proofs brought for this or that proposed revelation. But that is no disadvantage to a supernatural religion, such as the Christian, if it be, as we now suppose it to be,

true; and the real truth about religion itself does not require credulity, but only docility. And perhaps this matter may be illustrated, by comparing what happens to a philosopher in the examen of opinions, and to a chemist in that of metals. For if a piece of coin, that men would have pass for true gold, be offered to an ordinary man, and to a skilful refiner; though the latter will examine it more strictly, and not acquiesce in the stamp, the colour, the sound, and other obvious marks, that may satisfy a shop-keeper, or a merchant; yet when he has tried it by the severer ways of examining, such as the touch-stone, the cupel, aqua fortis, &c. and finds it to hold good in those proofs, he will readily and frankly acknowledge, that it is true gold, and will be more thoroughly convinced of it, than the other person, whose want of skill will make him still apt to retain a distrust, and render him indeed more easy to be persuaded, but more difficult to be fully satisfied. On the like account, though our virtuoso will examine with more strictness and skill, than ordinary men are able, miracles, prophecies, or other proofs, said to be supernatural, that are alledged to evince a revealed religion; yet if the certain and genuine characters of truth appear in it, he will be more thoroughly convinced of it than a less skilful man, whose want of good criteria (or touch-stones) and sound judgment will incline him to be diffident, and to be still afraid of having been imposed on.

I EXPECT in the mean time, that you should here object against what has been said in the later leaves of the past discourse, that it hath degraded the human intellect, by ascribing so much to experience, natural or supernatural, that it has left nothing for reason to do, unless servilely to obey.

BUT though this objection be plausible, yet the answer to it will not be very difficult, if the matter itself be duly considered, and reason be brought to act, even on this occasion, not as an interested party, but an unbiassed judge.

FOR we have already shewn, that rational philosophers scruple not to alter or renounce the opinions, that specious reasons had suggested to them, when once they either find those opinions contradicted by experience, or meet with other opinions more conformable to experience. And *Aristotle* himself, though he be accused to have, perhaps the first of all the ancient naturalists, perverted physics, by wresting them to a compliance with logical and metaphysical fancies; yet even he confesses, not only that in the science of nature, reason ought to comport with the phænomena, and the phænomena with reason; but that to adhere to plausible ratiocinations, with the neglect of sensible observations, is a weakness, or disease (*ἀσθένεια*) of mind. I will not here mention what I say in another paper, by way of attempt to settle the bounds of reason and experience, in reference to natural philosophy; but it may concern our present argument, to employ a few lines in this place, towards the further clearing the lately proposed objection. We may observe then, that, whether or no it be true, which is taught by *Aristotle*, and commonly received in the schools, that the understanding is like blank paper; and that it receives no knowledge, but what has been conveyed to it through the senses: whether, I say, this be or be not admitted, it is plain, that the notions, which are either congenite with the understanding, or so easily and early acquired by it, that divers philosophers think them innate, are but very few in comparison of those, that are requisite to judge aright about any one of a multitude of things, that occur either in natural philosophy, or theology. For in the divine nature, power, wisdom, and other attributes, there is a fecundity, that has produced a world of contrivances, laws, and other things, that exceedingly surpass both the number and variety, that the dim and limited intellect of man could reach to, by framing and compounding ideas, without the assistance of the patterns, afforded by the works and declarations of God.

ON the account of the same prerogative of the divine knowledge, it must frequently happen, that the notions and opinions men take up of the works and mind of God, upon the mere suggestions of the abstracted reason, (if I may so call it) newly spoken of, must not only be almost always very deficient, but will be oftentimes very erroneous. Of which we see evident proofs in many of the opinions of the old philosophers, who, though men of strong natural parts, were misled by what they mistook for reason, to maintain such things about the works and the author of nature, as we, who, by the favour of experience and revelation, stand in a much clearer light, know to be false, and often justly think utterly extravagant.

THE importance of the subject lately spoken of, and its being too little considered, may make it deserved to be inculcated; and therefore I shall subjoin on this occasion, that that, which I have lately called abstracted reason, is but a narrow thing, and reaches but to a very small share of the multitude of things knowable, whether human or divine, that may be obtained by the help of further experience, and supernatural revelation. This reason, furnished with no other notices than it can supply itself with, is so narrow and deceitful a thing, that he, that seeks for knowledge only within himself, shall be sure to be quite ignorant of far the greatest part of things, and will scarce escape being mistaken about a good part of those he thinks he knows.

BUT notwithstanding what has been hitherto said, I am far from intending to deny reason any of its just prerogatives. For I shew in another paper, that experience is but an assistant to reason, since it doth indeed supply informations to the understanding; but the understanding remains still the judge, and has the power or right to examine and make use of the testimonies, that are presented to it. The outward senses are but the instruments of the soul, which hears by the intervention of the ear, and in respect of which the eye itself is but a more immediate optical tube; and the sense does but perceive objects, not judge of them. Nor do the more wary among the philosophers, trust their eye to teach them the nature of the visible object; but only to employ it to perceive the phænomena it exhibits, and the changes that happen to itself by the action of it. And whereas it is confessed, that the sensories may deceive us, if the requisites of sensation be wanting, as when a square tower appears round at a great distance, and a strait stick half in the water appears crooked, because of the doubled medium; it is the part of reason, not sense, to judge, whether none of the requisites of sensation be wanting; which (give me leave to add) oftentimes requires, not only reason, but philosophy; and then also it is the part of reason to judge, what conclusions may, and what cannot be safely grounded on the informations of the senses, and the testimony of experience. So that when it is said, that experience corrects reason, it is somewhat an improper way of speaking; since it is reason itself, that upon the information of experience, corrects the judgments she had made before.

AND this (borrowed from the forementioned paper, because it was never published) prompts me to illustrate the use of reason, by comparing her to an able judge, who comes to hear and decide causes in a strange country. For the general notions he brings with him, and the dictates of justice and equity can give him but a very short and imperfect knowledge of many things, that are requisite to frame a right judgment about the cases, that are first brought before him; and before he has heard the witnesses, he may be very apt to fall into prejudicate opinions of things, (whether persons or causes.) But when an authentic and sufficient testimony has cleared things to him, he then pronounces, according to the light of reason, he is master of; to which the witnesses did but give information, though that subsequent information may

have obliged him to lay aside some prejudicate opinions he had entertained before he received it. And what is said of natural experience, in reference to the understanding, may, with due alteration, be applied to supernatural revelation: for here also the understanding is to examine, whether the testimony be indeed divine; and whether a divine testimony ought to be (as it will easily perceive it should) believed, in what it clearly teaches; to omit other uses of reason, (about theological matters) which belong not to this place, where it may suffice to have shewn, that reason is not degraded from the dignity, that belongs to her, of perceiving and judging; though she be obliged by her own dictates, to take in all the assistance she can from experience, whether natural, or supernatural; and by the fuller accounts of things she receives from those informations, to rectify, if need be, her former and less mature judgments.

IN short, those, that cry up abstracted reason, as if it were self-sufficient, exalt it in words; but we that address reason to physical and theological experience, and direct it how to consult them, and take its informations from them, exalt it in effect; and reason is much less usefully served by the former sort of men, than by the latter; since whilst those do but flatter it, these take the right way to improve it.

I HOPE you will not imagine, that I have in the foregoing part of this letter said all that I could say pertinently. For being mindful of the brevity becoming an epistolary discourse, I omitted several arguments, that would have challenged their places in a treatise; and have but touched upon most of those I have mentioned; though reasonings of this kind are usually like tapestry, which loses much by being looked on whilst the hangings are folded up, which should be displayed to their full dimensions.

BUT having offered you some things, which perhaps you have not met with elsewhere; and having, though but transiently, touched upon the grounds of divers other considerable arguments, I hope, that your learning and sagacity will both supply what you will discern to have been omitted, and enforce what has been but intimated; and then I shall not despair, that what I have said may suffice to persuade you, that experimental philosophy may greatly assist a well-disposed mind, to yield an hearty and operative assent to the principles of religion. I am,

S I R,

Your most, &c.

The End of the FIRST PART.

REFLEC-

R E F L E C T I O N S

UPON A

THEOLOGICAL DISTINCTION.

According to which it is said,

That some ARTICLES of FAITH are above Reason,
but not against Reason.

In a LETTER to a FRIEND.

ADVERTISEMENT.

AFTER the author had begun the second part of his *Christian Virtuoso*, and made some progress in it, which he designed to continue till he had completed it; he was obliged to leave the country, where he enjoyed some leisure, and to remove to London; where sickness, and business, and a multitude of visits he could not avoid receiving, did so distract him, that these remora's, added to the fertility of the subjects, that remained to be treated of, which he found much greater than he was at first aware of, made him lay aside the materials he had prepared for the second part, to a fitter opportunity, and comply with the occasions he had to publish some tracts, that required more. And it is for the like reasons, that having at present some other essays of a quite differing nature in the press, he is obliged to postpone his resuming and finishing the second part of the *Christian Virtuoso* (which will require more sheets than the former) for some longer time; though yet, to comply with the solicitations of the printer, he consents, both to let the first part come abroad, and (to make the book of a more decent size) add to it, by way of substitution, a discourse, that is of affinity enough to the other, upon the account of some of the points it handles, and more upon that of its scope; and that will not be ill received, if it have the good fortune to find the public as kind to it, as private perusers have been.

For my learned FRIEND Mr. H. O.

S I R,

I CAN neither admire nor blame the curiosity you expressed, to receive some satisfaction about the important distinction, that is made use of in defence of some mysteries of the Christian religion; namely, that *they are indeed above reason, but not against reason*. For though divers learned men have, especially of late, employed it, yet I perceive you and your friends N. N. think, that they have not done it so clearly, as both to prevent the exceptions of infidels, or render them more groundless; and at least, to obviate the surmises of those others, who have been persuaded to look upon this distinction but as a fine evasion, whereby to elude some objections,

that

that cannot otherwise be answered. And indeed, as far as I can discern by the authors, wherein I have met with it, (for I pretend not to judge of any others) there are divers that employ this distinction, few that have attempted to explain it, (and that I fear not sufficiently,) and none that has taken care to justify it.

II. IN order to the removal of the difficulties, that you take notice of, I shall endeavour to do these two things: 1. To declare in what sense I think our distinction is to be understood. And 2. To prove, that it is not an arbitrary or illufory distinction, but grounded upon the nature of things.

THOUGH I do not desire to impose my sentiments on any man, much less on you; yet because I, as well as others, have had some occasions to make use of the distinction we are considering, I think myself obliged, before I go any further, to acquaint you in what sense I understand it.

III. By such things then in theology, as may be said to be above reason, I conceive such notions and propositions, as mere reason, that is, reason unassisted by supernatural revelation, would never have discovered to us; whether those things be to our finite capacities clearly comprehensible or not. And by things contrary to reason, I understand such conceptions and propositions, as are not only undiscoverable by mere reason, but also, when we understand them, do evidently and truly appear to be repugnant to some principle, or to some conclusion of right reason.

IV. To illustrate this matter a little, I shall propound to you a comparison drawn from that sense, which is allowed to have the greatest cognation with the understanding, which I presume you will readily guess to be the sight. Suppose then, that on a deep sea, a diver should bid you tell him, what you can see there; that, which you would answer, would be, that you can see into a sea-green liquor, to the depth of some yards, and no further: so that if he should further ask you, whether you see what lies at the bottom of the sea, you would return him a negative answer. If afterwards the diver letting himself down to the bottom, should thence bring up and shew you oysters, or muscles with pearls in them; you would easily acknowledge, both that they lay beyond the reach of your sight, and consequently argued an imperfection in it; though but such an imperfection, as is not personal, but common to you with other men, and that the pearls have the genuine colour and lustre, that naturally belong to such gems. But if this diver should pretend, that each of these pearls he shews you, is as large as a tennis-ball, or some of them bigger than the shells they were enclosed in, and that they are not round but cubical, and their colour not white or orient, but black or scarlet; you would doubtless judge what he asserts to be not only (or not so properly) undiscernible by your eyes, but contrary to the informations of them, and therefore would deny what he affirms. Because, that to admit it would not only argue your sight to be imperfect, but false and delusory; though the organ be rightly qualified, and duly applied to its proper objects.

V. THIS illustration may give you some superficial notion of the difference betwixt a thing's being above reason, and its being contrary to it. But this may better appear, if we consider the matter more distinctly. And to offer something in order to this, I shall beg leave to say, that in my opinion, the things, that may be said to be above reason, are not all of one sort, but may be distinguished into two kinds, differing enough from each other.

VI. FOR it seems to me, that there are some things, that reason by its own light cannot discover; and others, that, when proposed, it cannot comprehend.

VII. AND first, there are divers truths in the Christian religion, that reason, left to itself, would never have been able to find out, nor perhaps to have so much as dreamed of; such as are most of those, that depend upon the free will and ordination of God;

as,

as, that the world was made in six days, that Christ should be born of a virgin, and that in his person there should be united two such infinitely distant natures as the divine and human; and that the bodies of good men shall be raised from death, and so advantageously changed, that the glorified persons shall be like (or equal) to the angels.

VIII. OF this kind of theological truths, you will easily believe, that it were not difficult for me to offer divers other instances; and indeed there are many truths, and more, I think, than we are wont to imagine, that we want mediums or instruments to discover, though, if they were duly proposed, they would be intelligible to us. As for my part, when by looking on the starry heaven, first with my naked eyes, and then with telescopes of differing lengths, I do not only descry more and more stars, according to the goodness of the instruments I employed, but discovered great inducements to think, that there are, in those inestimably remote regions, many celestial lights, that only the want of more reaching telescopes conceal from our sight.

IX. AND thus much I presume you will close with the more easily, because it disagrees not with the sentiments of some few (for I dare say not many) orthodox divines. But I must take leave to add, that, besides these mysterious truths, that are too remote and hidden to be detected by human reason, there is another sort of things, that may be said to be above reason.

X. FOR there are divers truths delivered by revelation, (contained in the holy scriptures), that not only would never have been found out by mere natural reason; but are so abstruse, that, when they are proposed as clearly as proper and unambiguous expressions can propose them in, they do nevertheless surpass our dim and bounded reason, on one or other of those three accounts, that are mentioned in a Dialogue about things transcending reason; namely, either as not clearly conceivable by our understanding, such as the infiniteness and perfections of the Divine Nature; or inexplicable by us, such as the manner, how God can create a rational soul, or how, this being an immaterial substance, it can act upon a human body, and be acted on by it; (which instance I rather chose, than the creation of matter, because it may be more easily proved;) or else asymmetrical or unfociable, that is, such as we see not how to reconcile with other things, which also manifestly are, or are by us acknowledged to be true; such as are the divine prescience of future contingents, and the liberty that belongs to man's will, at least in divers cases.

XI. IT will not, perhaps, be improper to observe, on this occasion, that as of things, that are said to be above reason, there are more kinds than one; so there may be a difference in the degrees, or at least the discernibleness, of their abstruseness.

XII. FOR some things appear to surpass or distress our understandings, almost as soon as they are proposed, at least before they are attentively looked into; as what is said to be infinite, either in extent or number. But there are other things, the notions whereof, as they first arise from the things considered in gross, and as it were indefinitely, are such, as do not choke or perplex our understandings; and are so far intelligible, that they may be usefully employed in ordinary discourse. But when we come to make a deep inspection into these, and prosecute to the uttermost the successive inferences that may be drawn from them, we reason ourselves into inextricable difficulties, if not flat repugnancies too. And to shew you, that I do not say this gratis, be pleased to consider with me, that we usually discourse of place, of time, and of motion, and have certain general indeterminate conceptions of each of these, by the help of which we understand one another, when we speak of them; though

though, if we will look thoroughly into them, and attentively consider all the difficulties, that may be discovered by such an inspection, we shall find our reason oppressed by the number and greatness of the difficulties, into which we shall argue ourselves, or at least may be argued by others; though these men, who do make such shrewd objections against the hypothesis we embrace, will hardly be able themselves to pitch on any, that will not allow us to repay them in the same coin.

XIII. What has been newly said may, I hope, assist us to clear a difficulty, or scruple, (about the distinction we treat of), which, since it sprung up in my own mind, may very probably occur also to your thoughts; namely, that, if any theological proposition be granted to surpass our reason, we cannot pretend to believe it, without discovering, that we do not sufficiently consider what we say; since we pretend to exercise an act of the understanding, in embracing somewhat, that we do not understand, nor have a notion of.

XIV. But on this occasion we may justly have recourse to a distinction, like that I have lately intimated. For, in divers cases, the notions men have of some things may be different enough, since the one is more obvious and superficial, and the other more philosophical or accurate. And of these two differing kinds of conceptions I have already offered some instances in the very differing notions men have of place and time; which, though familiar objects, I elsewhere shew to be each of them of so abstruse a nature, that I do not wonder to find *Aristotle* himself complaining of the difficulty, that there is to give a clear and unexceptionable notion of place; nor to find so acute a wit as *St. Austin* ingenuously confessing his disability to explicate the nature of time.

XV. AND what is said of the great intricacies, that incumber a deep scrutiny into these familiar objects of discourse, will hold as to the divisibility of quantity, as to local motion, and as to some other primary things, whose abstruseness is not inferior in degree, though differing as to the kinds of things, wherein it consists.

XVI. By such instances as these, it may appear, that without talking as parrots, (as your friends would intimate, that those that use our distinction must do), or as irrational men, we may speak of some things, that we acknowledge to be on some account or other above our reason; since the notions we may have of those things, however dim and imperfect, may yet be of use, and may be in some measure intelligible, though the things they relate to may, in another respect, be said to transcend our understanding; because an attentive considerer may perceive, that something belongs to them, that is not clearly comprehensible, or does otherwise surpass our reason (at least in our present state).

XVII. HAVING dispatched the objection, that required this digression; I shall now step again into the way, and proceed in it by telling you, that any one apposite instance may suffice to clear the former part of the expression, that is employed, when it is said, that a mystery, or other article of faith, is above reason, but not contrary to it: for if there be so much as one truth, which is acknowledged to be such, and yet not to be clearly and distinctly comprehensible, it cannot justly be pretended, that to make use of the distinction we are treating of is to say something, that is not intelligible, or is absurd. And it will further justify the expression quarrelled at, if we can make it appear, that it is neither impertinent or arbitrary, but grounded on the nature of things. And this I shall endeavour to do, by shewing, that though I admit two sorts of things, which may be said to be above reason, yet there is no necessity, that either of them must (always) be contrary to reason.

XVIII. As for the first sort of things said to surpass reason, I see not, but that men may be unable, without the assistance of a more knowing instructor, to discover
some

some truths; and yet be able, when these are revealed or discovered to them by that instructor, both to understand the disclosed propositions by their own rational faculty, and approve them for true, and fit to be embraced. The intellect of man being such a bounded faculty as it is, and naturally furnished with no greater a stock or share of knowledge, than it is able by its own endeavours to give itself, or acquire; it would be a great unhappiness to mankind, if we were obliged to reject, as repugnant to reason, whatever we cannot discover by our own natural light; and consequently, to deny ourselves the great benefits we may receive from the communications of any higher and more discerning intellect. An instance to my present purpose may be found among rational souls themselves, though universally granted to be all of the same nature. For though a person but superficially acquainted (for example) with geometry would never have discovered by his own light, that the diameter of a square is incommensurable to the side; yet when a skilful mathematician dextrously declares, and by a series of demonstrations proves, that noble theorem, the disciple, by his now instructed reason, will be able both to understand it, and to assent to it; inso-much that *Plato* said, that *he was rather a beast than a man, that would deny it.*

XIX. OTHER instances may be alledged to exemplify the truth newly mentioned. And indeed, there is not so much as a strong presumption, that a proposition or notion is therefore repugnant to reason, because it is not discoverable by it; since it is altogether extrinsic and accidental to the truth or falsity of a proposition, that we never heard of it before; or that we could never have found it out by our own endeavours; but must have had the knowledge of it imparted to us by another. But then this disability to find out a thing by our own search doth not hinder us from being able by our own reason both to understand it when duly proposed, and to discern it to be agreeable to the dictates of right reason. To induce you to assent to the latter part of this observation, I shall add, that these intellectual assistances may oftentimes not only enlighten (but gratify) the mind, by giving it such informations, as both agree with its former maimed or imperfect notices, and compleat them. When, for example, an antique medal, half consumed with rust, is shewed to an unskilful person, though a scholar, he will not by his own endeavours be able to read the whole inscription, whereof we suppose some parts to be obliterated by time or rust, or to discover the meaning of it. But when a knowing medalist becomes his instructor, he may then know some (much defaced) letters, that were illegible to him before; and both understand the sense of the inscription, and approve it as genuine, and suitable to the things whereto it ought to be congruous. And because divers philosophical wits are apt, as well as you, to be startled at the name of mystery, and suspect that, because it implies something abstruse, there lies hid some illusion under that obscure term; I shall venture to add, that agreeably to our doctrine we may observe, that divers things, that relate to the old testament, are in the new called mysteries, because they were so under the Mosaic dispensation; though they cease to be so, now that the apostles have explained them to the world. As the calling of the Gentiles into the church of God is by their apostle called a mystery; because, to use his phrase, it "had been hid from ages and generations;" though he adds, "but now it is made manifest to his saints." And the same writer tells the *Corinthians*, that he "shows them a mystery," which he immediately explains, by foretelling, that all pious believers shall not die, because that "those, that shall be found alive at the coming of Christ, shall not sleep, but be changed;" as the other "dead shall be raised incorruptible." Which surprising doctrine, though, because it could not be discovered by the light of nature, nor of the writings of the old

Col. i. 26.
Eph. iii. 3,
5, 6.
1 Cor. xv.
51, 52.

testament, he calls a mystery, yet it is no more so to us, now that he hath so expressly foretold it, and therefore declared it.

See Matth.
xiii. 11.
Eph. v. 31.

XX. OTHER instances I content myself to point at in the margin, that I may pass on to confirm the observation I formerly intimated; that divers things, which the scripture teaches beyond what was known, or (in probability) are discoverable by natural light, are so far from being against reason, by being (in the sense declared) above it, that these discoveries ought much to recommend the scripture to a rational mind; because they do not only agree with the doubtful or imperfect notions we already had of things, but improve them, if not compleat them. Nay, I shall venture to add, that these intellectual aids may not seldom help us to discern, that some things, which not only are above reason, but at first sight seem to be against it, are really reconcileable to reason, improved by the new helps afforded it by revelation. To illustrate this by a philosophical instance: when *Galileo* first made his discoveries with the telescope, and said, that there were planets that moved about *Jupiter*; he said something, that other astronomers could not discern to be true, but nothing that they could prove to be false. And even when some revelations are thought not only to transcend reason, but to clash with it; it is to be considered, whether such doctrines are really repugnant to any absolute catholic rule of reason, or only to something, which so far depends upon the measure of acquired information we then enjoy, that, though we judge it to be irrational, yet we are not sure, that the thing, this judgment is grounded on, is clearly and fully enough known to us. As, to resume the former example, when *Galileo*, or some of his disciples, affirmed *Venus* to be sometimes horned like the moon; though this assertion were repugnant to the unanimous doctrine of astronomers, who thought their opinion very well grounded on no less a testimony than that of their own eyes; yet in effect the proof was incompetent, because their unassisted eyes could not afford them sufficient information about this case. And so when *Galileo* spoke of hills and valleys (and shadows) in the moon, they were not strait to reject what he taught, but to have, if not a kind of implicit faith, yet a great disposition to believe what he delivered, as upon his own knowledge, about the figure and number of the planets. For they knew, that he had, and had already successfully made use of, a way of discovering celestial objects, that they were not masters of, nor therefore competent judges of, all the things, though they might well be of many, that he affirmed to be discoverable by it. And though they could not see in the moon what he observed, (vallies, mountains, and the shadows of these) yet they might justly suspect, that the difference of the idea that they framed of that planet, and that which he proposed, might well proceed from the imperfection of their unaided sight; especially considering, that what he said of the differing constitution of what is there analogous to sea and land, did rather correct and improve, than absolutely overthrow, their former notices. For he allowed the spots they saw to be darker parts of the moon, and gave causes of that darkness, which their bare eyes could not have led them to any such knowledge of. And the non-appearance of the mountainous parts of the moon in that form to the naked eye might well be imputed to the great distance betwixt them and us, since at a far less distance square towers appear round, &c.

XXI. IT now remains, that I say something, that may both make some application of the form of speech hitherto discoursed of, and afford a confirmation of the grounds, whereon I think it may be justified. This I am the rather induced to do, because I expect it will be objected, that he that acknowledges, that the thing, he would have us believe, transcends our reason, has a mind to deceive us, and procures

for himself a fair opportunity to delude us, by employing an arbitrary distinction, which he may apply as he pleases.

XXII. BUT to speak first a word or two to this last clause, I acknowledge, that such a distinction is capable enough of being misapplied; and I am apt to think, that by some school-divines, and others, it has been so. But since there are other distinctions, that are generally and justly received by learned men, and even by philosophers themselves, without having any immunity from being capable to be perverted; I know not, why the distinction we are considering should not be treated as favourably as they. And however, the question at present is not, whether our distinction may possibly be misapplied by rash or imposing men, but whether it be grounded on the nature of things. To come then to the thing itself; I consider, that for an opinion to be above reason, in the sense formerly assigned, is somewhat, that (as was noted in reference to the first sort of things that surpass it) is extrinsic and accidental to its being true or false. For to be above our reason is not an absolute thing, but a respective one, importing a relation to the measure of knowledge, that belongs to the human understanding, such as it is said to transcend: and therefore it may not be above reason, in reference to a more enlightened intellect, such as in probability may be found in rational beings of an higher order, such as are the angels, and, without peradventure, is to be found in God, whom when we conceive to be a Being infinitely perfect, we must ascribe to Him a perfect understanding and boundless knowledge. This being supposed, it ought not to be denied, that a superior intellect may both comprehend several things, that we cannot, and discern such of them to be congruous to the fixed and eternal ideas of truth, and consequently agreeable to one another, as dim-sighted mortals are apt to suspect, or to think to be separately false, or, when collated, inconsistent with one another. But to launch into this speculation would lead me farther than I have time to go. And therefore I shall content myself to offer you one argument, to prove, that of things, that may be said to be above reason, in the sense formerly explained, it is no way impossible, that even such an one should be true, as is obnoxious to objections not directly answerable. For I consider, that of things above reason, there may be some, which are really contradictory to one another, and yet each of them is maintainable by such arguments, as very learned and subtle men do both acquiesce in and enforce, by loading the embracers of the opposite opinion with objections they cannot directly answer.

XXIII. THIS I take to be manifest in the case of the controversy about the endless divisibility of quantity, as suppose of a strait line. For many eminent mathematicians, and a greater number of naturalists, and in particular almost all the Epicureans, and other atomists, stiffly maintain the negative. The affirmative is nevertheless asserted, and thought to be mathematically demonstrated by *Aristotle* in a peculiar tract; and both by his school, and by several excellent geometricians besides. And yet in reality the assertions of these two contending parties are truly contradictory; since of necessity a strait line proposed must be, at least mentally, divisible, into parts, that are themselves still further divisible; or it must not be so, and the subdivisions must at length come to a stop. And therefore one of the opposite opinions must be true. And it is plain to those, that have, with competent skill and attention, impartially examined this controversy, that the side, that is pitched upon, which forever it be, is liable to be exposed to such difficulties, and other objections, as are not clearly answerable, but confound and oppress the reason of those, that strive to defend it.

XXIV. I HAVE, Sir, the more largely discoursed of the foregoing distinction, not only because I did not find myself to have been prevented by others, but because I look upon the explaining and justifying of it to be of importance, not alone to the defence of some mysteries of the Christian religion, but (what perhaps may have escaped your observation) of some important articles of natural theology itself. For though natural religion taught divers heathen philosophers, such truths as these, *viz.* the production of the rational soul or mind, which is an immaterial substance; the formation of the world out of the universal matter, though this action required, that an incorporeal substance gave motion to a body; that God knows men's thoughts and intentions, how carefully soever they strive to hide them; and that God foreknows the events of the free actions of such men, as are not to be born these many ages: though, I say, these and some other sublime truths were by divers men embraced before the gospel began to be preached; yet when I attentively consider, how hard it is to conceive the *modus* of these things, and explain how some of them can be performed; and also, how some of the divine attributes, as eternity, immensity, omnipresence, and some others, belong to God; and how some actions, as the moving of bodies, and the creation of human minds, with all their noble faculties, are exercised by Him: when I consider such things, I say, I acknowledge, that, to my apprehension, there are some doctrines, allowed to have been discovered by the mere light of nature, that are liable to such objections from physical principles, and the settled order of things corporeal, as, if they be urged home, will bring those, that are ingenuous, to acknowledge, that their intellects are but dim and imperfect, and indeed disproportionate to the sublimest and most mysterious truths; and that they cannot perfectly comprehend them, and answer all the difficulties that incur upon them, though they find themselves obliged to admit them, because of the weighty positive reasons, that recommend those heteroclite truths to their assent.

XXV. If you should now tell me, that, after all I have said, it is plain, that the questioned distinction, if it were granted, might be of very bad consequence, as affording shelter to any unintelligible stuff, that some bold enthusiast, or conceited philosopher, may obtrude under the venerable title of a mystery, above the jurisdiction of reason; and that, though the distinction were admitted, it would not be a good proof of any disputed article of the Christian religion: if, I say, this shall be objected, I shall answer, (what in part is intimated already) that I do not deny, but that our distinction is liable to be ill employed; but that this is no other blemish than what is common with it to divers other distinctions, that are without scruple admitted, because they are useful, and not rejected, because they have not the privilege, that they can never be misapplied. And therefore, both in reference to those distinctions, and to that we have been treating of, it becomes men to stand upon their guard, and strictly examine, how far the notion, or doctrine, proposed as a mystery, does require, and is entitled to the benefit of this distinction. I shall also readily grant the greatest part of the second member of your objection. For I think it were great weakness in a Christian, to urge our distinction as a positive proof; since, though it be extrinsic to an abstruse notion, to be, or not to be, above reason, (as was just now noted to another purpose); yet, generally speaking, that abstruseness is less fit to bring credit to a conception, or a doctrine, than it is to make it to be distrusted. Nor are Christians such fond discoursers, as to pretend, that such an article of religion ought to be believed, because it is above reason, as if that were a proof of its truth; but only, that, if it be otherwise well proved, it ought to be believed, notwithstanding its being above reason.

XXVI. AND this I shall represent in favour of those, that believe abstruse articles, that are clearly revealed in the scripture, upon the authority of the divine Revealer, (who never deceives others, nor can be Himself deceived), that since, as we have lately shewn by the contradictory opinions about the divisibility of quantity, some doctrines must be true, whose difficulties do not appear to be surmountable by our dim reason; and since the perfectness of God's knowledge permits us not to doubt, but that He certainly knows which of the two contending opinions is the true, and can declare so much to men; it would not be a sure ground of rejecting a revealed article, to alledge, that it is encumbered with confounding difficulties, and liable to many and weighty objections.

XXVII. AND (to add somewhat, that may help to defend some truths of natural, and others of revealed religion) that a thing may be rationally assented to upon clear positive evidence, though we cannot directly answer the objections, that a speculative and subtil wit may devise against it, is a truth, which, as important as it is to religion in general, and the Christian religion in particular, I think one may sufficiently manifest by this one instance, that because we can walk up and down, and so remove our bodies from place to place; by this one argument, I say, we are justly satisfied, that there is a local motion in the world, notwithstanding all the specious and subtil arguments, that *Zeno* and his followers have employed to impugn that truth: against which they have alledged such difficulties, as have not only puzzled and perplexed but (for aught yet appears) nonplus'd the ancient philosophers, and, I doubt, those moderns too, that have attempted to give clear solutions of them.

XXVIII. IF now, Sir, we look upon what hath hitherto been discoursed, I hope you will allow me to gather thence the conclusion I aim at, which is, that there is no necessity, that every notion or proposition, that may be found delivered in the holy scriptures, that surpasses our reason, must therefore be contradictory to it: and that in case the Christian religion be true, and its mysteries or other articles divinely revealed, it is not enough for the confutation of any of them, to reject the expression, that it is above reason, but not contrary to it; as if it involved an unintelligible or groundless distinction: for though this will not evince the truth of a mystery, since that must be established upon its proper grounds and arguments; yet it will keep it from being therefore absurd or false, because it transcends our reason: since to do so may belong almost indifferently to a chimerical notion, and a mysterious truth. And if the expression be employed to justify any thing, that, though stiled a mystery, is but a pretended one, the error will lye, not in the groundlessness of the distinction, but the erroneousness of the application. I am,

S I R,

Your most, &c.

G R E A T N E S S of M I N D

P R O M O T E D B Y

C H R I S T I A N I T Y.

In a LETTER to a Friend.

The F I R S T P A R T.

To my honoured Friend Sir R. M.

S I R,

I Do not wonder, that a great soul, like yours, should enquire, what aspect religion, and particularly that of Christians, has upon *greatness of mind*: but I confess, I somewhat marvel, that you should be put upon the enquiry by the suggestions of such a libertine as Mr. N. N.'s confidently pretending, that his atheistical and sensual principles are much more friendly, than the doctrines of Christianity, to a noble frame of mind. Wherefore I dare not permit the sense I have of my own weakness, how great and just soever, to keep me from presenting you with my thoughts; and the rather, because I presume you are not indisposed to receive a satisfaction in this point, since you seem to expect it from a pen, that is no better than mine; which, you well know, must not be on this occasion assisted by the arguments and ornaments, that the fine sentences of the fathers, and other divines and humanists, might afford to a person, that were at leisure, and furnished with a library. Yet I shall not much either excuse or deplore my being so ill accommodated for the task you impose upon me; because as you seem to desire but my own thoughts, so I know not, whether common place-books would afford me any great assistance on so uncommon a theme; and, I confess, that, when the matter will bear it, I, as well as you, do less care for authorities, especially taken from discourses, designed rather to persuade than prove, in comparison of those arguments, that are suggested by a due consideration of the nature of the thing. But yet, I presume, you will readily give me leave to do that frequently enough, which your friend perhaps will call preaching. For besides that your desires, and my haste, confine me to the Bible and my own thoughts; the frequent citation of texts of holy scripture is exacted by the nature of the question I am to handle: it being necessary, for the evincing of the doctrines of Christianity not to be inconsistent with greatness of mind, that we as well consider, what those doctrines are, which sure will be best declared by the scriptural texts that contain them, as what are the attributes of greatness of mind.

C H A P. I.

TO proceed then with some method, as well as much brevity, I conceive it will be no unfit way to come to a resolution in our inquiry, if I first set down and enumerate the chiefest things, that in the estimation of intelligent men do, as if they were so many ingredients, make up what we call magnanimity or greatness of

of mind, that not being a single star, but a constellation of elevated and radiant qualities; and then shew, that religion, especially that of the Christians, is at least consistent with each of these, if it do not also promote it. But in this enumeration, though I shall, *ex abundanti*, take in some qualities, that are not essential to greatness of mind, but rather accessions to it; yet I shall not scrupulously distinguish those things, that are necessary to compleat it, and those that are partly some of them signs, and some of them effects, of it; hoping from your equity, that these additional things will be thought to make full amends, if, through haste or mistake, I should chance to have omitted any property, that you may judge to belong to the true notion of generosity.

I SHALL, in the following discourse, take it for granted, (and I hope I need not tell you that I do so), that as we think not masons, but jewellers, fit to judge of the genuineness and value of precious stones; so you will allow me to take the notion and measures of greatness of mind, not from the opinions of the injudicious vulgar, but the judicious estimates of reason, improved by philosophy, and enlightened by natural theology.

I KNOW the undiscerning multitude, whose judgment seems rather lodged in the eye than in the brain, when they hear men name greatness of mind, are apt to fancy something, that, like the coronation of a king, is attended with pomp and splendor, and a numerous train of gazers, and the loud acclamations of the people. And, at least, when mention is made of an heroic soul, they imagine, that it cannot be but in a great commander, like a Roman emperor, or a Tartarian general, that leads and defeats armies, and desolates whole countries, and leaves them peopled only with carcases. But reason and religion, that look on human things with eyes untroubled by those pompous outsidings, that dazzle the vulgar, can easily see a vast difference betwixt greatness of fortune and greatness of mind. And not only Christianity teaches, that ‘God, who is no Προσωπολήπτης, respecter of persons,’ *Acts* x. 34. ‘sees not persons as man sees them;’ *2 Sam.* xiv. 14. and that ‘a thing that is sublime amongst men, may be an abomination to Him.’ But philosophers themselves can easily distinguish betwixt that real greatness, that truly belongs to the man, and that theatrical one, that fortune may have annexed to his condition. And, though they pay a peculiar honour and respect to great virtue in sovereigns, rather than in subjects, because in the former it is more diffusively beneficial, and cannot last without resisting stronger temptations; yet, they do not think, that a great empire always either finds, or makes, a great soul. And if dignities, how high soever, be attained by mean submissions, or weak actions, they think this extrinsecal greatness can no more make a mean soul great, than high stilts can make a dwarf a proper man. Perhaps they look upon many, who, for making a great bustle and noise in the world, are, by themselves, and the shallow vulgar, thought great spirits, but as gnats, that are in themselves small and worthless creatures, and are really considerable for nothing, save the noise and the stings wherewith they are able to disturb men’s rest. That lucky monarch, that overcame so great a part of the then known world, and conquered countries, faster than one would have thought he could have travelled over them, has this character given of his stupendous exploits by the Roman historian, that all he had done was, ‘that he durst well despise despicable things.’ And in a poet of the same nation this is his elegy,

*Felix terrarum prædo, non utile mundo
Editus exemplum.*

AND if such persons as they had so little respect for so great a monarch, that was a lawful sovereign; what liberty, think you, do philosophers allow themselves, who

so little value the favourites of fortune for their being so, that even such as those prosperous usurpers, *Phocas*, &c. that her fondness, and the applause of a multitude, (as blind, perhaps, as she is painted) have seated in the throne, philosophers, in their thoughts, do as well doom to a scaffold, as religion does to hell? And certainly, true greatness of mind must be something, that both resides in the soul, and is perfective of it; neither of which properties belong to any thing, that fortune can bestow: and all that outward greatness can do is not to make a soul great, but to afford one, that is, the opportunity of shewing itself to be so. And all these submissions and respects, that custom, or fear, or interest, make men pay to those, whom only their titles, or their places, or their power, make great ones, do as little argue or increase the real worth of those envied persons, as the standing for more than formerly in an account turns a brass counter into silver or gold. And as no less skill in arithmetic is required, to multiply, &c. a thousand farthings than a thousand guineas, though one of the latter be worth above a thousand of the former; so the ordering or disposing of all things according to the best rules, and after the best manner they are capable of, may argue no less greatness of mind in a private man, than is exercised by a great monarch, in those actions, that attract the eyes, and busy the tongues, of nations. And as it usually speaks a man a better artist to make a pocket-watch, than a great town-clock, all the advantage the latter has of the former consisting in the greatness of the matter that is wrought, and not that of the skill that is displayed; so it sometimes happens, that those productions of virtue argue a greater soul, that make by far a lesser shew and noise. And you may remember, not only that *Socrates*, notwithstanding his private, and even necessitous, condition, was by the oracle preferred to all the *Grecians*, when *Greece* was the theatre of generous minds; but, that a far truer oracle than that of *Delphos* pronounced the poor widow's mind, and circumstances, to have made her mite a greater liberality, than all that the rich man had bestowed upon the Corban. And it is the sentence of no worse a judge than *Solomon*.

Mark xii.
43.
Prov. xvi.
32.

LET us not then, from the mean notions of the vulgar, and the fond opinions of common souls, take our estimates of so sublime and extraordinary a quality, as greatness of mind. For many things, to which they give not only their approbation but their applause, are, and ought to be, as little esteemed, if they be condemned by the wise, as a piece of brass money, that has long passed current among the people, ought to be thought good gold, when refiners and say-masters have declared it counterfeit. And if you ask me, what notion then of greatness of mind I am willing to allow, I shall freely tell you, that, in my apprehension, the man, that has a great mind, is he, that uses his utmost moral diligence to find out what are the best things he can do, and then, without being deterred by dangers, or discouraged by difficulties, does resolutely and steadily pursue them, as far as his ability and opportunities will serve; and this out of an internal principle of love to God and man, and with a sincere aim to glorify the one, and benefit the other.

C H A P. II.

BUT, before I descend to particulars, it will not be amiss to take notice of one consideration, that may, in general, make it probable, that the Christian religion is rather favourable, than opposite, to true magnanimity. That this argument may make somewhat the more impression, I shall, though very briefly, observe, that the aspects, both of the Author, the rules, the aims, or scopes, and the rewards of virtue, as it is recommended by Christianity, have a great and direct tendency to elevate it, and make it heroic.

AND

AND first, the prime Author of the doctrine of the gospel being God Himself, who both knows man perfectly, and is mentioned in scripture as a *Φιλάνθρωπος*, Tit. iii. 4. or Lover of mankind; it is but reasonable to suppose, that the doctrines and laws He caused to be solemnly delivered to mankind, and confirmed by miracles, and whose system is, in the Apocalypse, honoured with the title of the everlasting gospel, Rev. xiv. 6. (*i. e.*) not to be succeeded by a more perfect institution, as the Mosaic law was by that, should be fitted to beget and advance solid and sublime virtue, and be, more than any other institution, perfective of human nature.

NEXT, the rules, and (if there be any such) the counsels of the Christian religion require, and tend to, extraordinary degrees of virtue. The divine Legislator, being able to look into the hearts of men, makes his laws reach those, and those principally too. The "loving God with all our hearts, with all our minds, &c. and our neighbour as ourselves," as comprehensive as those two grand principles of virtue are, is by our Saviour made the summary of the moral law, and adopted into the gospel; the "cleansing ourselves from all filthiness, both of flesh and spirit;" and 2 Cor. vii. 1. the "abstaining from all kind or appearance of evil," are the negative parts of the 1 Thess. v. Christian's duty; and for the positive parts, we are plainly told, that, "unless our 22. righteousness exceed that" boasted one "of the scribes and pharisees, we shall not Mat. v. 20. enter into the kingdom of heaven." We are urged "to grow in grace, to add 2 Pet. iii. 18. i. 3. to our faith, virtue," and to that, a whole train of excellent qualities. And, for fear any such thing should be thought to be purposely omitted, because left unmentioned, this general exhortation is given us; "finally, my brethren, whatsoever Phil. iv. 8. things are true, &c." But there is yet a more aspiring path of virtue traced us out in the gospel, where it proposes to us the example of Christ, as one, whose steps we are to tread in: for not only that divine Person never committed any sin, neither 1 Pet. ii. 22. was guile found in his mouth; but the supreme and omniscient Judge, God Himself, declared, by a voice from heaven, his full approbation, both of his person, and his doctrine, when He said, "This is my beloved Son, in whom I am well pleased; Mat. xvii. 5. hear ye Him." And his sinless life, which was a living law, did not only surpass the examples, but even the precepts and the ideas too, of the heathen moralists and philosophers, as may be elsewhere shewn. And the becoming a serious disciple of so perfect and divine a Teacher does itself so engage a man to renounce his former vices, that, when St. Paul had dissuaded his Romans from divers other vices, instead of exhorting them to the contrary virtues in particular, he only desires them, in general, "to put on the Lord Jesus Christ," as a comprehensive duty, which Rom. xiii. 14. contained in it all the virtues, he declined to enumerate.

THIRDLY, but though He calls us to high degrees of virtue, yet He does not to unattainable ones: for, though philosophy wisely forebore (though not always to commend, yet) to enjoin things disproportionate to human infirmities; yet He may well be allowed to engage us to more than human virtues, that by his divine assistances, if they be duly sought, is always ready to enable us to acquire and practise them. "Of his fulness," says St. John, "we have all received, and grace for grace;" John i. 16. (*i. e.*) either graces answerable to his, as the faculties of a child's mind are to those of a perfect man; or, grace upon grace, (*i. e.*) an accumulation of graces heaped upon one another; which may keep you from wondering, that St. Paul should dare to say, "that he could do all things through Christ, that strengthened him." And Phil. iv. 13. where his invitations meet with an honest and a willing mind, his commands do not only chalk out the way, but give strength to walk in it; and He usually does, by his Spirit, such a kind of work, as He sometimes did miraculously by his power, when He at once bid and enabled a paralytic person, that wanted strength to stir Mat. ix. 6.

Matt. xiv. 29. from his bed, to rise and walk; and when, having commanded St. Peter to walk to Him upon the sea, He enabled him securely to tread upon the waves; thereby approving and rewarding the excellent notion that disciple had, that the command of Christ was a sufficient cause to put him upon action, though a miracle were requisite to carry him through with it.

FOURTHLY, the rewards proposed to virtue and piety by the Christian religion do exceedingly tend to animate and heighten them, whether we consider the recompences the gospel propounds in this life, or those that it promises in the next. The great present rewards of virtue are, you know, the approbation of good men, and the applause of a man's own conscience. The first of these is as well attainable by Christian heroes, as by any other; for virtue loses neither its worth nor amiableness by being baptized; and though in some times and places lesser degrees of it may be disregarded, or traduced, yet, generally speaking, the greater degrees of it will either invite or extort men's esteem. Among the Roman persecutors, the exemplary lives and constancy of the primitive Christians brought it to be proverbially said, *that such a man was a good man, saving that he was a Christian*; and, *Soli Christiani mortis contemptores* was usually in heathen's mouths. There are divers qualities, and those more pressed by the Christian than any other institution, that have in them so much of native loveliness, that St. Paul might justly say of them, "that he that exercises himself in them, is," generally speaking, "both acceptable to God, and approved by men." Nor did those virtues, that recommended the great Constantine, whilst he was a Gentile, lose their lustre, or the veneration they procured him, when he turned Christian, and practised them with higher aims, than that of satisfying himself, and pleasing his people.

Rom. xiv. 18.

AND as for the reward of a good conscience, which was able to make Hercules undergo all his labours, and made all the other heroes of the Gentile world; I think, it will not be doubted, but that this inward recompence is received, not only without any defalcations, but with great improvements, by him, whose virtues flow from religion. For to him the applauses of conscience may well be more acceptable than all the various sorts of music, that solemnized the dedication of Nebuchadnezzar's golden image, since in him conscience does not, as in mere natural men, act only the part of a domestic judge, but that of a delegate from God Himself; and its absolutions are less welcome, as they are approbations of reason, than as they are the pledges of God's acceptance, and of that higher reward, that will be consequent to it in the life to come.

Dan. iii. 7.

FOR these joys, that are placed on the other side of the grave, are much the noblest part of the recompence of virtue, and proportionable incitements to the practice of it; and yet, on the account of future rewards, the Christian has much greater motives to heroic virtue, than the heathen moralist or philosopher. For the posthume state of man is so dim and uncertain, that we find even the greatest men among the heathens speak very doubtfully, and not without ifs and ands, of a future state, and much more of a future happiness, as may be instanced in *Socrates*, *Cyrus*, *Seneca*, and many others; so that they rather seemed to have wished, or hoped, than believed, their future felicity: and, I fear, that many of them, finding that happy state described chiefly by the poets, reckoned it among poetic fictions. And those, that did, though but waveringly, expect recompences in the life to come, had but poor and mean ideas suggested to them of it; the hopes they were entertained with being of fortunate islands and the Elysian fields, which are not so transcendent, as to make a diffident man very forward to quit the gardens of *Epicurus*, that he has here in possession, upon the doubtful hopes of other gardens in *Elysium*. Whereas, to ex-

cite the Christian to an heroic degree of virtue, he is not allowed to hope, but commanded to be entirely confident of passing out of this world into a place, to which the poets Elysium is much more inferior, than the possession of a garden is to that of an empire. To attempt the description of that celestial happiness, would be, contrary to my inclination, to launch out into a common place; and were a work, that, if my haste did not, my disability would dissuade me from: and therefore, though it be a state made up of the confluence of all sorts of things rationally desirable, yet having only said in general of all the other goods, that it comprizes, that the scripture tells us, "that eye has not seen, nor ear heard, nor the heart of man conceived, what God has laid up for them that fear him;" I shall particularly take notice only of those parts of this inestimable reward, that may peculiarly concern my present purpose, by being the chief things, that heroic souls are wont to aspire to, a good name, honour, and dignity. 1 Cor. ii. 9.

To have a good name for good actions cannot but be a very desirable thing, the applause of wise and good men being a loud echo from without, that by repeating it confirms the approbation given by the conscience within. But though to do virtuous and worthy actions be the best and likeliest way of acquiring a good name, yet it is not a certain one: for such is the ignorance, the malice, or the enmity of a great many, that no man is sure to escape being misrepresented or traduced, as we see that the sublimity, the brightness, and the regular courses, of the stars themselves, could not hinder wanton poets, or fanciful astronomers, from giving those luminous constellations the names not only of the nobler beasts, as the lion, the eagle, and the whale; but even of animals, that lye under an ill name, as the dog, the goat, and scorpion. And though it be true, that oftentimes innocency, long clouded, does, like lightning, break out at last; yet oftentimes too that happens not, till malice and envy are dead, because the maligned person is so; by which means he does not live to know he is justified, and many, if not all, of those misinformed men are dead and gone, for whose good opinion he was chiefly concerned. But though the Christian may, as well as any other, be traduced by calumny, which often serves good men as the heathen persecutors did the martyrs, (when they exposed them to the people's view, clothed in the skins of beasts, to make them hideous and hateful); yet he is justly cheered by the assurance he has, that there will come a time, when oppressed and disfigured innocency shall shine forth and triumph, and his good name, as well as his body, shall have a glorious resurrection, even in the sight of his accusers and enemies, and of all those, whom their slanders did either prevail with, or startle. For at that great and general assize, to which there shall be a far greater confluence than the Assyrian monarch drew to the plains of *Babylon*, the heroic disciples of the apostles will be able to say, upon happier terms than the apostles themselves did here below, that they are made a "spectacle to God, to angels, and to men." And in that illustrious assembly of the "first-born, whose names are written in heaven," being present, the men, not only of all nations, but of all ages, the vizards shall be as well taken off as the masques; and the formerly traduced saints being welcomed with the title of "good and faithful servants," shall solemnly be acquitted by the sentence, not of a fallible or partial judge, but of an infinite and supreme One, "that searches the hearts and reins," and cannot be deceived or bribed; and, to be sure that the injured saint shall come off with honour enough, he shall then be absolved by being crowned. Dan. iii.
1 Cor. iv. 9.
Heb. xii.
Matt. xxv.
Jer. xvii. 10.

THIS celestial crown comprehending, in the scripture dialect, both the remaining parts of the Christian's reward, honour and dignity, or glory and preferment; it will be pertinent to mention some advantages, that give it an high preference above the crowns of monarchs here below.

AND first, earthly crowns may sometimes be the fruits and recompences of worth and virtue, but are not at all the proofs of them. They are usually the gifts of nature, and not unfrequently of fortune; and history gives us cause to wish, they were more seldom the acquits of crimes. But the celestial crowns proclaim, though not the merit, the worth of them that receive them, being never adjudged but to such, whom previous graces and virtues have fitted and qualified for "the inheritance of the saints in light."

BESIDES, as an earthly crown may be acquired without merit, so it may be possessed without happiness. And if crimes be made steps to a throne, they prove so many thorns to him that sits on it, who is there a more illustrious (not a less tormented) malefactor; the sublimity of a throne, as little as the height of a scaffold, keeping a criminal person from feeling the punishments inflicted on him there. As may appear by the instance of *Herod Agrippa*, whose throne, and glistering habit, which *Josephus* takes notice of, though they procured him not only the acclamations, but adorations, of the dazzled multitude, could not protect him from the incensed justice of an higher King than he; so that, whilst others treated him as a god, he found himself one of the most miserable of men, and was fain to hasten from a seat, which occasioned (but could not protect) his impiety. But a celestial crown, as it is graciously bestowed for the supreme recompence of virtue, and on that account may be called a crown of righteousness; so it always proves a blessing, as inseparable from happiness, as a thing is from itself. The crowns of this world, by the very advantage of being hereditary, shew, that they cannot preserve the possessors from death. But the crown, I speak of, is, by the divine Bestower of it, called "a crown of life;" and of it, in respect of other crowns, may be truly said, what *Solomon* said of wisdom, in reference to other goods, that the excellency of it is, that it gives "life to the owner thereof." And though earthly crowns be such transitory things, that we may observe, that even the four great monarchies of the world were by God represented to *Nebuchadnezzar* but as parts of a dream, whereas the kingdom, promised to Christians, is called in the scripture "a kingdom that cannot be moved," as the believers crown is, in opposition to those fading crowns of laurel, that adorn the heads of the Roman conquerors, called an "unwithering crown of glory:" as if the laurel, placed on the Christian's head, could grow and flourish in the wreath, better than it did on the tree.

BUT all that I have yet said is inferior to this last prerogative of the celestial crown, that it does not only confer a relative dignity or pre-eminence, but an essential worth and excellency; as if the diamonds, which adorned that crown, should impart their own sparkliness, transparency, and incorruptibility, to the person that wears it. The highest preferments here below do raise a man above others, without raising him above himself. By being at the top of a ladder, a man comes to an higher station, but is not really taller than he was; and a vane, by being placed on the top of the highest steeple, is not from iron turned into gold or silver, but remains still of the same base metal it was, and is but a weather-cock, and so the sport of the winds. But a celestial crown is always attended with a personal improvement, besitting so high a dignity. The heavenly coronation has a virtue like that of the unction of *Saul*, who, upon his being made king, was enabled to prophesy, and was turned into another man. And the resemblance holds in this too, that Christ is said to have made his redeemed ones, not only "kings, but priests to God and his Father;" as if the kingly dignity were not enough, unless the sacred character of a priestly office were added. Congruously to which, *St. Peter* calls Christians, in general, a "royal priesthood;" the understanding, the will, the affections, are all refined and elevated,

elevated; and the very body itself is transformed into a spiritual body. As if the glorified soul did shine, with an undiminished splendor, through its happily changed mansion. And we may well suppose, that this will be a bright and noble structure, if we remember, that the angels, who, in their apparitions to good men, were wont to be very careful not to frighten them, did yet appear with a majestic splendor; and that angel, that the apostles saw in our Saviour's sepulchre, is represented, as a young man clothed "in a long white and shining garment." And we are told by St. Paul, that, in the future state, "our vile bodies shall be transformed into the likeness of his glorious body;" and how glorious it is in heaven, we may guess, by what it was at his transfiguration here on earth, during which, the scripture relates, "that his face did shine as the sun, and his raiment was white as the light." And of Moses and Elias, though they came to speak to him of his death, it is added by St. Luke, "that they also appeared in glory." And since our Saviour has assured us, that "those that shall be accounted worthy of that state," shall be like, or equal to the angels; and that then the "righteous shall shine like the sun in the kingdom of their Father," who knows but, that the transfigured soul and body of some happy saint may be as glorious a sight, as that which appeared to St. John in the Apocalypse, when he saw an angel "standing in the sun?" If it be said, that these are very bold hyperboles, I hope the texts, I have mentioned, will keep them from seeming altogether groundless conceits. And when, among other excellent prerogatives, that our Saviour promises the persevering believers, one is, "that he will give them power over the nations, and to rule them with a rod of iron;" and the other, which may well be the last, is expressed in these words. "To him that overcometh, will I grant to sit with me in my throne, even as I overcame, and am set down with my Father in his throne." And though I readily yield, that these expressions are not to be strictly and literally taken; yet, when I consider the infinite power, and goodness of God; and that, for ought we know, he may have numberless dominions, and sets of governable creatures, that we are yet strangers to; I think, God's attributes, and Christ's expressions, may warrant us to expect amazing things from him, that is able, and has declared himself willing, to do for us "above what we can ask, or," in our present state, so much as "think." And, at least, that will be allowed me, which I drive at in this celebration of our future happiness, that the Christian religion, by proposing such inestimable rewards, presents believers with far higher motives to heroic virtue, than morality, or philosophy, can afford other men.

ADVERTISEMENT.

THE author being desired to add yet something to the foregoing discourses, to give the book they make parts of, a thickness more proportionate to its largeness; he did, among other papers of his, that he turned over, in compliance with that request, light upon an epistolary discourse, which by its very being unfinished seemed (by reason of its shortness) the more fit to serve the present turn. For this tract having been drawn up in a country, whence the author was obliged to remove, before he had made any considerable progress in his work; he was easily induced to put it up in a bundle of other writings, which, like this, were laid aside, till he should be at much leisure to complete them. But, upon the newly mentioned occasion, finding, that among divers loose and lesser memoirs, that had been thrown together in order to the designed treatise, there were fifteen or twenty pages at the beginning that were coherent enough; he was content they should attend the Christian virtuoso, because of the affinity of the things designed in both the papers; which being to re-

commend the Christian religion to worthy souls, it was congruous enough, that a discourse, which shews, that the Christian religion may very well consist with a philosophic genius, should be accompanied by another, that tends to manifest, that greatness of mind, which comprises uncommon degrees of virtue, is not only consistent with Christianity, but may be highly promoted by it. Those, that reflect on this aim, will not (it is hoped) think it strange, that the stile is a little raised; since though the subject be theological, yet the writer (who was then many years younger than he now is) being a person of honour, and writing for a noble gentleman, who, like himself, was a layman; it was thought not only allowable, but fit, that the stile should not be altogether unsuitable to the subject and to the aim; which was to make impressions on an illustrious person, not by dry precepts, or languid discourses, but by exciting him to heroic virtue, by the noblest patterns and ideas, and the most moving incentives, he could propose.

AND though the discouragements lately mentioned, and since encreased by the author's not being able to find some of the principal materials he had, in loose sheets, provided for the following discourse, oblige him to lay aside the thoughts of completing it; yet because it is very possible, that some elevated soul may have a mind to prosecute the design, or cultivate so noble a subject; he thought it not amiss (as little samples of his method or way of treating it) to subjoin to the greater fragment, besides the index of the heads of discourse, intended for the first part, five or six lesser fragments, that he lighted on, whilst he was seeking for some papers belonging to the same tract, that should have been, but were not found in their company.

C H A P. III.

First fragment.

TO have high aims and noble designs, is so genuine a mark, and effect of greatness of mind, that there is not any more generally acknowledged; insomuch that ambition, though it be but a depravation or a counterfeit of this heroic frame of mind, does yet so dazzle the eyes of the greater part of men, as to pass for magnanimity; and noble attempts do oftentimes, even when they fail of success, not miss of esteem.

—*Magnis tamen exidit ausis,*

was meant for an encomium by him, that said it. And I remember, that one of the ancients reckons it among the glories of that great captain *Hannibal*, who long successfully disputed with the Romans the empire of the world, that he resolved to besiege *Rome*, though he never proved able to lead his army within the sight of her walls.

Now as to have elevated aims is one of the chief signs, and indeed parts of an heroic temper of mind; so there are no men, that seem to me to have nobler and sublimer aims, than those, to which a true Christian is encouraged; since he aspires to no less things than to please and glorify God, to promote the good of mankind, to improve, as far as possible, his personal excellencies in this life, and to secure to himself for ever a glorious and happy condition in the next.

C H A P. IV.

Second fragment.

ONE of the grand difficulties, that he, who would be highly virtuous, must expect to surmount and conquer, especially in such a degenerate age as ours, is the temptation, that is afforded by the universality of vicious customs and examples.

I wish

I wish it were needless solicitously to prove, either how great an influence examples, especially bad ones, have on the generality of men; or how general bad examples have been in most ages, and in particular in that we live in. The scandal given by bad examples, though it be one of the most obvious temptations, is none of the least dangerous. For interest, bashfulness, and that very complaisance and civility, that is so usually found in well-bred or good-natured persons, makes them very unwilling to offend or disoblige the company they live with, and whom they have several inducements rather to please and gratify by imitation and compliance, than tacitly to reproach by non-conformity to their sentiments, and practices. And in effect we find, that many, that could not be perverted by the frowns and threats of the vicious, have been debauched by their company and example. Against this powerful temptation religion strongly arms its hero, both by precepts and precedents. "Thou shalt not follow a multitude to do evil," was the express command of the Mosaic law. "Say not thou a confederacy to all to whom this people shall say a confederacy," was the command of God to his prophet. Our Saviour makes it an argument to dissuade his disciples from an anxious solicitude about meat and drink, and clothing, that after all these things the Gentiles (which are by far the most numerous part of mankind) do seek. And upon the same ground, he endeavours in the same divine sermon upon the mount, to keep them from vain repetitions in prayer. And whereas it may seem an immodesty to dare to dissent from others, that vastly surpass us in number; the heroic conqueror of *Canaan* speaks thus to the whole body of the victorious Jewish nation, that they may choose to serve whom they thought fit, and worship either the gods, whom their fathers served, or those worshipped by the neighbouring nations; "but as for me and my house, we will serve the Lord." "Be you not conformed to this world," says *St. Paul*. And another apostle, speaking of himself and the true Christians of his time, scruples not to affirm it passionately and roundly, "we know, that we are of God, and the whole world lies in wickedness."

Nor does religion furnish us with precepts only to disobey custom and example, but with precedents too, of which there are three so illustrious, that I know not how to pass them by. The first is afforded by *Lot*, who lived in a place, that was grown so proverbial for the height of wickedness, that to aggravate their sins by the most hyperbolical comparison, we must liken them to themselves; and they were grown so wicked, that in a place, where an admirable plenty, and an unbounded libertinism could not but make them very populous, there could not be found half a score of good men, the generality of that cursed people being fallen so much, not only from virtue, but from common honesty, that they did not restrain themselves so much as to human vices. And yet, even the sins of *Sodom*, which cried so loud as to reach heaven, and bring down fire and brimstone from thence, disturbed *Lot's* quiet, without destroying his innocence; and an apostle assures us, that that "just man was but vexed with the filthy conversation of the wicked," not prevailed with in the least to imitate it.

THE next instance of a religious courage, inflexible to bad examples, is afforded us by the three friends of *Daniel*, who, at the great solemnity of the dedication of *Nebuchadnezzar's* golden image; when they had, besides that great and stern monarch's command, the example, not only of many men, but many nations, and a more numerous assembly of persons, considerable for quality and dignity, than the world ever saw before or since, singly opposed their naked constancy to the haughty tyrant's menaces, and the prostrate world's example. And yet these men were courtiers, bred among that supple sort of fine creatures, that were as accustomed to bow their consciences, as their knees to their proud master. They had not only lives to lose,

lose, but the chief dignities of the province of *Babylon*, then the queen of nations. And they could not upon their refusal quit the stateliest palace in the world, without immediately changing it for a burning fiery furnace.

THE last instance I shall name, and the most illustrious that can be named, is that I am supplied with by *Noah*: he lived in an age, in which there were as many heinous sinners almost as there were men: though vice has generally had a *Benjamin's* portion in the distribution of mankind betwixt it and virtue, yet, *Methusala* excepted, the inequality was grown such, as gave vice rather a monopoly than a share of men; or if a distribution were to be admitted, it was such a one as that made of *Saul* and his army, when all the people were on one side, and only he and *Jonathan* on the other. It is strange, that when the world was so recent, that many that were then alive might remember and converse with one, that for two hundred years lived contemporary with *Adam*, (for so we may gather *Methusala* to have done) men should so soon forget all sentiments of piety. But yet in *Noah's* time the world could not be compared to its present state, where though it be night in one place, it is day in another; but to the state of *Tobu va Bobu*, or the first chaos, where darkness was over the face of the universal deep. For the scripture tells us, "that all flesh had corrupted his way upon the earth, that every imagination of the thoughts of man's heart was only evil continually." And though *Noah's* family were saved with him in the ark, yet it may be doubted, whether that were a certain token of their being untouched by the general contagion. For that wonderful vessel contained beast clean and unclean, harmless and rapacious, and in it were saved wolves as well as lambs, and vultures as well as doves. And where God gives the reason, why he vouchsafed to receive *Noah* and his house into the ark, he expresses it thus; "for thee have I seen righteous before me in this generation," without making mention of any of his family. Nor was the wickedness of the antediluvian world more universal than it was great; that mungrel breed were guilty of sins as gigantic as themselves. The text says, "that the earth was filled with violence" through them; and those impious rebels against their maker broke the laws of nature with an insolence, that provoked him to break off the course of nature to punish them, since nothing less than an universal deluge of water could place limits to such an impetuous and overflowing impiety. But all these sinful examples, how general soever, could not prevail on *Noah* so much as to keep him from giving one of a quite contrary nature: the scripture calls him an herald or "preacher of righteousness;" and though it appears not, that he made any converts, he persevered in his rejected admonitions for six score years, a time long enough to have tired his patience, especially since he did not any of his hearers obstinacy. And his constancy raised him as much above the reach of their temptations, as the waters that punished their sin raised his ark above their drowned mansions. And now go and compare with any constancy of the following times, where virtue has always had some party, though not a numerous one, this unequalled singularity of *Noah*, which God himself seems to have taken special notice of, not only by that patriarch's wonderful preservation, but by saying emphatically, "thee have I seen righteous before me in this generation," which was so brutish and depraved, that I know not, whether he were not obliged to live among worse brutes before he finished the ark than afterwards, when in it he was shut up with lions, foxes, and tygers.

ANOTHER virtue, that belongs to a great mind, is constancy, or persevering patience in afflictions. This quality hath so noble an appearance, that when it is exercised even by malefactors, it obtains our esteem; and whilst we cannot so much as excuse their actions, we cannot but commend the manner of their suffering for them: calmness

ness of mind, in the midst of outward storms, being something, that looks so handsomely, that crimes and gibbets cannot keep it from doing so; nor hinder those, in whom it is found, from being both pitied and applauded.

THAT this part of greatness of mind is befriended by the Christian religion, more than by any other institution, will appear; if we consider, what it contributes to constancy and patience, under outward pressures and calamities, by precept, by examples, and by arguments.

C H A P. V.

HUMILITY is a virtue, that, at the first blush, seems so distant from greatness of mind, that some would think it improper to refer the former to the latter, under any other notion, than that of an opposite. But, whatever may be thought of humility, solitarily considered, yet, when we find it in conjunction with those other qualities, that contribute to make up greatness of mind, it adds to their number; and though it does not perhaps shine as bright as some of them, is as amiable as any; and imparts somewhat of its own loveliness to all the rest. And you will not much wonder, that I place this virtue among those that constellate, if I may so speak, an heroic mind, if you consider, whence humility may in such a soul proceed, and what difficulties it may surmount. For if wealth, honor, and other outward blessings exalt our hero's condition; to be humble, in the midst of such advantages, argues a mind elevated above the presents of fortune, and speaks a soul great enough to undervalue those things, that ordinary souls admire; and which even men, that pass for great, make the objects of their ambition, and, when attained, of their pride. And if our hero be ennobled with great virtues, or famous for great actions; his humility argues, that he has so raised an idea of virtue, and dares aspire to such a pitch of it, that he cannot rest satisfied with greater attainments, than persons, but ordinarily virtuous, aim at; and looks upon himself as obliged and born to an unwearied pursuit of heroic and still increasing degrees of excellency. And if a laudable practice, by being extremely difficult, is a mark of a great soul, humility must not be denied that character; for this is a virtue more difficult to excellent, than to ordinary, souls. In other cases, a hero is to contend but with his vices, or his passions, or his open enemies; but to be humble, he must overcome his virtues too; and that, when they act unitedly as one body: since, though other virtues naturally assist one another, they all conspire to ruin humility; which, having pride to contend with, is to deal with so subtle an adversary, that sometimes even by being foiled he overcomes. And as the torpedo poisons his arm, that wounds it; so sometimes in the best arguments we employ against pride, the very strength and seeming success of them tempts the maker of them to be proud; and I will not swear, that, at this very time, I exalt our hero's humility, without any diminution of my own.

To the attainment of an eminent degree of this lovely both virtue and grace the gospel conduces, by furnishing its embracers with express injunctions, clear directions, high rewards, and other weighty motives, and the noblest patterns and perfectest examples, that ever were or can be given.

The Heads of the Discourse, entituled, "Greatness of Mind
" befriended by Christianity."

THE INTRODUCTION.

Fifth frag-
ment.

1. **O**F the true notion of greatness of mind.
 2. Of the tendency, that the Christian religion has to promote greatness of mind in general.
 3. THAT Christianity gives men noble aims, such as the glory of God, the pleasing of him, the general good of men, personal excellencies in this world, and eternal happiness in the next.
- THE virtues or qualifications, which, as so many constituent parts, make up greatness of mind, and are peculiarly befriended by Christianity, are chiefly these,
4. COURAGE or valour.
 5. CONSTANCY and patience in afflictions.
 6. BOUNTY or liberality.
 7. FORWARDNESS to oblige.
 8. READINESS to forgive.
 9. A JUST and impartial estimate of riches, and other things, that ordinary men covet and admire.
 10. HUMILITY.
 11. A CONTEMPT of all that is base.

The END of the FIRST PART.

G R E A T.

GREATNESS of MIND

PROMOTED BY

CHRISTIANITY.

The SECOND PART.

THE former discourse has, I hope, sufficiently manifested, that, of the several virtues and noble qualities, that make up true greatness of mind, there is not any, that is not at least consistent with Christianity, and that most of them are eminently promoted by it. But I expect your *Φιλόδοξος* will pretend, that there are some qualities required by our religion, that directly and powerfully tend to debase the mind they possess; and hinder it from attaining, or even aspiring, to such great things, as it would reach to, if it were not detained or depressed by religion. Let us now therefore examine, whether, notwithstanding the wings, which we have shewn that religion adds to the mind, the clogs, that it fastens to her, be heavy enough to disable her to raise herself above the pitch of vulgar souls, and force her, instead of soaring aloft, to flutter about the earth.

THE chief things, that, as far as I can learn, are alledged, either by *Philodonus*, or more considering adversaries than he, to shew religion to be either quite inconsistent with, or very unfriendly to, greatness of mind, are these——

[But, in regard, that I find not the answers, that were drawn up to the objections; and it is not so convenient to let the latter appear unaccompanied by the former, it is thought the safest way to leave them both at present unmentioned; and only take notice, that to the last of the six objections, which, to deal candidly, were named and considered, these words were found subjoined.]

AND now, if it appear, that neither any nor all of these have such an unfriendly aspect on greatness of mind, as is pretended; and that at least the impediments, they can bring, are much more than countervailed by the assistances, that religion affords heroic virtue; I hope it will appear, that greatness of mind is not incompatible with Christianity, but rather promoted by it.

Experimenta & Observationes Physicæ:

Wherein are briefly treated of

SEVERAL SUBJECTS

RELATING TO

NATURAL PHILOSOPHY

IN AN

EXPERIMENTAL WAY.

To which is added,

A small Collection of STRANGE REPORTS.

A LETTER that may serve for a Preamble.

To my learned Friend Mr. *H. Oldenburg*, Secretary to the Royal Society.

S I R,

BEING at length come to a resolution, I have already done something more than barely entered upon that way of writing, that you and I have more than once discoursed of together; and wherein you particularly (though not you only) among my learned friends have wished to see me engaged.

It is not, that I am insensible of the prejudice, which the things I deliver are like to sustain, by the disadvantageous dress, wherein they must appear, in the way of writing I have pitched upon; which being for the most part plainly historical, and set down in the order wherein they chanced to come to hand, denies most of them, not only the usual ornaments of other books, but the allowable advantages, that method, elaborate discourses, neat hypotheses, and subtile disputes, are permitted to bring even to philosophical writings.

BUT these considerations were overswayed by a sad one, founded upon the (yet continuing) condition I was in, when I was debating this matter in my thoughts. For it having pleased God (to whose always most just dispensations men ought entirely to submit) to afflict me with the stone and the palsy; as on one side, these added to a sufficient number of avocations scarce permit me any great expectation of finishing in a short time the tracts I had made a lesser or greater progress in, according to my first design; so on the other side, my friends judging it unfit, that the materials provided for these more than begun treatises should be quite lost, or kept too long useless, it seemed expedient,

pedient, that as opportunity should from time to time serve, I should look over my memorials, and other scattered papers, to take notice, what experiments and observations were to be found in them.

UPON these and the like inducements, having picked up several of my dispersed papers, some of them written many years ago, and some of a less ancient date, I began to refer the most part of what I found historical in them, together with some few things, that did seem necessary not to be severed from them, to certain heads or titles, which I called chapters; and made them the more numerous, that they might singly be the less prolix: and about these I must desire your leave to represent some things by way of preface.

AND first, several of the ensuing particulars, that I met with among my papers, being parts of essays, or other discourses, and being for haste transcribed for the most part verbatim, as they were couched there; I dare hope for your excuse, if among such transcripts you now and then meet with things, which, how pertinent soever to the tracts they first belonged to, might have been spared as needless, if not sometimes foreign also, in the new form the discourses are now put into; since I could not leave out such unnecessary clauses (whereof yet I hope you will not find many) without too much mutilating the coherence, or obscuring the sense of what is delivered; and I could not alter them, and adapt others to supply their places, without spending more time, and taking more pains, than in the condition I am now in, I suppose you would be willing to condemn me to.

NEXT I despair not, but you will allow me the liberty I have taken, to vary the bulk and method of particular chapters, as my occasions would permit, or the plenty or paucity of materials suggested, or the nature of the thing I treated of, and the scope I proposed to myself in writing of it, seemed to require. But sometimes my want of health and leisure, and my desire to hasten to other subjects, that either pleased me better, or seemed more considerable, made some of the following chapters, compared with others, but short; especially if I were supplied but with a number of things pertinent to that subject, by the papers I had then in hand, how much soever I may have written of it in other papers, which I hope hereafter to be master of.

AND this advertisement may render you a reason, why to the title of some of the chapters I have subjoined the first section, though it be not at present followed with a second.

AND as for my having employed very differing methods in some of the ensuing tracts, I did it with design, as judging such a variety of methods more conducive to my purpose, than uniformity in it would have been. For besides that some of the treatises, whence these chapters were taken, did by the ways, wherein they were already written, oblige me to accommodate myself to their method; I thought, that if you should shew these papers to any, that are very unacquainted (which I have heard you complain, that too many are) with the way of accommodating, in some tolerable manner, his enquiries and his writings to the several subjects he applies himself to, he may be somewhat helped by the differing examples he may here meet with, to make variations somewhat suitable to the differing natures of the subjects he deals with.

BUT here I must beg you to take notice, that though in compliance with this design, as well as for some other reasons, I have in several of the following chapters given intimations and hints of things, which I do not there prosecute; and now and then propose some conjectures and opinions, whose proof I do not insist on; yet I am not willing you should think, that however some of those passages may be but occasional

things,

things, mentioned principally to excite, and give hints to the inquisitive and sagacious; yet all, or most of them, are of the same kind; and that I thought not on them, but as slightly and transiently as I mentioned them; and have no better and other reasons to alledge for my suspicions or intimations, or even for my conjectures or my opinions, than those you will meet with in papers hastily drawn up; especially since, I think, I can shew you divers of the things delivered in those passages, enlarged and rendered at least probable or practicable in other discourses, that for certain reasons do not accompany these I now send you.

I EXPECT, that you should think it somewhat strange, to find many of the following experiments set down much less circumstantially, than those that are mentioned in the physico-mechanical experiments touching the air; in the continuation of them; in the history of cold; and in some other books of mine, that you have been pleased to peruse. But on this occasion give me leave to represent to you, that the nature of divers of the former experiments, especially chemical ones, and my aims in mentioning them, being considered, it seemed not requisite they should be more fully treated of: and as for others, though the brevity and dispatch, which divers reasons made me propose to myself, had not forbidden me to amplify; yet I daily feel my leisure, not to say my life too, so torn piece-meal from me by sickness, visits, business, and inevitable avocations, that I am frequently admonished to hasten the securing of as much as conveniently I can, by dispatching particular subjects, and am quite hindered from dwelling so long upon them, as if I had more health and leisure, I should willingly do. To these things perhaps so favourable a person as Mr. *Oldenburg* will add, that the characters, which learned writers, English and foreign, though divers of them personally unknown to me, have been pleased to give of the intelligence and sincerity employed in setting down the *physico-mechanical experiments*, and those of some other writings of mine, may permit me to hope, that it will be thought, that after having been divers years versed in making trials and experiments, I have made them with some care and wariness, and mentioned them faithfully, where I have not done it amply, upon hopes it may be taken in good part from a person in my present condition, that was never a professor of philosophy, nor so much as a gownman; to have made shift to make the experiments and observations he communicates, and set them down truly and candidly, without fraudulently concealing any part of them, for fear they should make against him. And though perhaps you will easily believe, that in divers of the experiments which I have but briefly mentioned, I have been as diligent an observer of circumstances, as I was wont to be when I made those, which have had the luck to be taken notice of for being fully related; and though it may be also, that some scruples or objections, which my brevity may in part occasion, were not unforeseen by me, and might have been avoided by a more copious and diffused way of writing; yet I purposely decline such a way of delivering things, not only for the reasons above mentioned; and because I suppose them, that may peruse these papers, to be acquainted with my formerly published writings, and to have either from them, or otherwise, understood the way of making such experiments as mine; but also, because, though I wanted time and health much less than I do, I should not think it fit too much to prevent the industry of others about the trials I mention; and reap the field so clean, as not to leave them, not only store of ears to glean, but some corners of standing corn; I have therefore here and there purposely omitted both, some not absolutely necessary practical directions about making of trials, that might prevent such scruples or objections, as have the grounds of answering them clearly delivered in my printed books; and several, not only lesser circumstances, but considerable phaenomena, and obvious applications, that may probably occur to others, as they did to me in making the trials, and reflecting on them.

Advertise-

Advertisements about the Disposition of the following Treatise.

YOU will quickly discern, that the following chapters could not be intended for complete tracts about the subjects handled in them. And indeed they were intended but for such memoirs about the various particular subjects they treat of, as may be serviceable to the solid natural history, that has been nobly designed, and is still prosecuted by the Royal Society. Wherefore since (at least in our age) no writer, that I know of, has so early and so well, both urged the necessity of natural history, and promoted divers parts of it by precepts and specimens, as the illustrious Lord *Verulam*; I shall not scruple in the way or manner of writing these short collections of mine, to make use somewhat frequently of his authority and examples, but without confining myself to either.

I. AGREEABLY to this advertisement you will find, that some of the particulars, that the following treatise consists of, are single, and as it were, independent ones; upon which account they resemble those, which in the *Verulamian Sylva*, or Natural History, are called experiments solitary: and have for that reason induced me to give that title to each of the several chapters, that are made up of them.

II. ANOTHER sort of chapters there is, wherein divers experiments and observations, all of them relating to the same subject or purpose, are set down together. These, if they were ranged and sorted in order to distinct theories, I shall call, in imitation of the mentioned author, experiments in consort. But my backwardness to frame theories has made me chuse to forbear as yet to methodize them; and therefore has made me think fit to call them only various experiments and observations, about this or that subject, which they belong to.

III. My haste, though not that only, induced me to make one sort of chapters more, that partly agrees with, and partly differs from each of the two that I come from mentioning: for in every one of these chapters, there are two or three, if not more, single or solitary experiments; and there are also others, that have some kind of connexion among themselves, as being referable to the same subject or purpose. On that score the title, that is given to each of the chapters of this third sort, is that of miscellaneous experiments, and sometimes (but seldomer) of promiscuous ones. And all the particulars, that I refer to the three forementioned heads, are cast into chapters, wherein the several kinds are distinguished only by their titles, or not.

IV. THERE is one advertisement, that regards all the sorts of particulars, that are referred to the forementioned chapters; which is, that I have usually comprehended observations, as well as trials, under the title of experiments; which I have done, not only upon the authority, and in following the example of our judicious chancellor, (as is every where obvious in his *Sylva Sylvarum*) but for other reasons to. For both the sorts of particulars may pass for matters of fact, and so are historical, taking the word in a lax sense; and the employing it in that sense makes the articles or passages, whereof the chapters and other parts of our collection consist, much more commodious for references and citations.

V. BESIDES the three forementioned kinds of chapters, you will meet, in the ensuing treatise, with another sort of writings, whereof some are almost entire, and others fragments of larger discourses. In neither of these did I confine myself so much to matters of fact, as in those chapters, that consist of experiments and observations; but took the liberty, as occasion required, to enlarge in discourses, and sometimes to cite such passages out of other mens writings, as I judged I could make some pertinent application or use of, perhaps unthought of by the author. And these papers
being

being most, if not all of them written in a more free and discursive way, I thought fit to separate them from the sets of collections, that are almost merely historical, and accordingly I have not stiled them chapters, but titles; and have forborn to assign them, as I did the others, ordinal numbers; which I desire likewise you would not prefix to any of them, because I am not yet resolved how I shall dispose of them, either by supplying what is wanting to finish any one or more of them, or by taking to pieces, and employing those pieces as materials for other tracts,

VI. PERHAPS I shall not be thought to need pardon, if to comply with their curiosity, who affect most those experiments, that are either uncommon, or teach them to do or perform something useful or pretty; I sometimes prefix a title, declaring what it treats of, to a particular experiment (or observation) which for its importance, novelty, or usefulness (theoretical or practical) may deserve to be distinguished; since by this means such particulars may be better impressed on the memory, to gratify those, whose nicety or want of leisure may make them well pleased by a transient view of the titles we speak of, to find such passages, as they chiefly looked for, with less trouble than that of perusing an index.

VII. AMONG the experiments our collection consists of, there is here and there one, to which it was thought fit to add something, either by way of explication, or of illustration, or of confirmation, or of answer to objections, or of theoretical reflection, or of practical application, &c. And these supplements or additions it was thought fit to call sometimes annotations, but oftner scholiums, because that term is freely used in a very comprehensive sense by mathematical writers. But though I readily acknowledge, that this term has been chiefly employed by mathematicians; yet the use of it has not been so confined to them, but that good authors in other parts of learning have not scrupled to employ it, as may appear by the scholiums, that some learned physicians have written upon *Hollerius*, an eminent person of their profession; as also by the example of the famous and experienced *Forestus*, who has not seldom subjoined scholiums, even to his own medicinal observations.

VIII. THE mention of these scholia prompts me to tell you, I had almost forgotten, but yet must not leave unmentioned, that I thought fit now and then to premise to sets of experiments, and sometimes (though more seldom) to a single observation, a short preamble by way of introduction, which may often excuse the need of subjoining a scholium, and may be warranted by the example of the Lord *Verulam* in his centuries, wherein he often inserts such short preambles, as things fitted to give light to the experiments they belong to, and to give some advertisement, both of the nature and importance of the subject, and of the scope of the writer, or of other useful circumstances.

IX. IF among my own experiments, namely, those that I have made or seen, I have sometimes inserted experiments or observations that are not so; I have not done it without reason, and am authoris'd in that practice by frequent examples afforded me by the first, if not only author that I know of, that gave us a set of precepts of well writing natural history, our often cited *Verulam*, whose centuries do in great part consist of borrowed experiments and observations; without which he was sensible, that his *Sylva* must be of too narrow a compass, or too thinly stocked with plants, especially with trees. And indeed it is not to be expected, that as the silk-worm draws her whole mansion altogether out of her own bowels, so a single man should be able to write a natural history out of his own experiments and thoughts. And he, that will strictly confine himself to those, will be often reduced to omit things very pertinent, if not necessary to his subject, which is of practice studiously declined by me, who prefer the reader's utility to the ambition'd glory of being thought to borrow nothing

nothing from any body. And I can add in my defence, at least in my excuse, that I have made use but of a small part of the liberty allowed me by the example of so great a guide in the way of writing natural religion. For I have very much seldomer than he employed the trials of others, and have yet seldomer mentioned unverified reports or vulgar traditions, being careful, that the bulk of the matters of fact I deliver should consist of things, whereof I was myself an actor, or an eye-witness; and that the comparatively few borrowed experiments, that I added, (that I might not deprive my reader of some things very pertinent and useful to my subject) were received from persons of very good credit; besides that I do not only frequently give sufficient intimation in the experiment or observation itself, but oftentimes, by placing the letter C in the margin, do give notice; nay, and sometimes to a whole set prefix the title of communicated experiments or observations.

X. I HAVE nothing more to give you notice of here, save that, whereas you will find, that I write but on one side of the leaves, whereof this book * consists; I did so for two reasons. The first, that in case I should have occasion to employ any of these experiments in other treatises, for which I am more concerned than for this rhapsody, I might have room to substitute, if it should be thought fit, one or more of my later experiments in its place. And secondly, that I might have room, if I can get leisure, to write annotations, or make reflections, or illustrations, or corrections, or, in a word, such additions and alterations of particular experiments and passages, as they shall be thought fit to deserve or need.

I AM sensible, that this preamble, increased by the advertisements, that it was thought necessary to annex to it, is of a length, that may seem disproportionate to the book or tract it is prefixed to. But I may, in excuse of this, represent to you, that the bundle of writings you now receive is but a part of the book; to which, if God vouchsafe me health and leisure, this preface, enlarged by its appendix, is designed for an introduction. And in that case it is hoped, that these preliminaries, as many as they are, will not be thought impertinent, or needlessly prolix.

Experimenta & Observationes Physicæ.

T O M E I.

C H A P. I.

Containing Chémico-Magnetical Experiments and Observations.

THE loadstone, *Pyrophilus*, is so admirable a body, and its usefulness to mankind is already so great, without denying us hopes of farther improvements, that I think we must want curiosity or gratitude, if we neglect either to take notice of any experienced phænomena, that directly relate to so abstruse a subject, or, by

* This refers to the manuscript that was sent to Mr. O. and is left to shew the intention of the author.

confining them to paper, to preserve them from oblivion. It is chiefly by this consideration, *Pyrophilus*, that I am induced to mention to you the following experiments and observations, made most of them by the help of the fire. For though some of them may seem but slight, yet they may not prove unuseful towards discovering the nature of a body so strange and singular, that, for aught is yet manifest, any true magnetical phenomena may somewhat conduce to the knowledge of it. And I was the rather induced to make trials and observations of this kind, because most of them are such, as I have not met with in authors. And the few, that remain, I have not found sufficiently taken notice of there; philosophers and mathematicians aiming chiefly, in their magnetical writings, to prosecute and apply the attractive and directive, and perhaps the inclinatory, faculty of the loadstone. Whereas, throwing into another paper what I observed of that kind, I did in the present enquiry mainly intend to make the loadstone rather the object than the instrument of my trials; and, handling chiefly the very substance of the stone, endeavour not so much to advance or apply its faculties, as to weaken and destroy them, though in order to the better knowing of them. Having therefore procured a considerable number of, for the most part, naked (or uncapped loadstones, most of them coarse, but of differing sizes, shapes, colours, and countries; I made upon them several trials, some of which I should immediately proceed to give you a brief account of, but that it will be proper to premise this short advertisement; that I would not have the title of these experiments make you expect, that the fire should be a main agent in every one of them; since, to preserve some few of them, I refer them hither, though an actual fire was not employed to make them; since the common rule, that *a potiori parte fit denominatio*, will suffice to warrant, or at least excuse my giving to this small collection the title of *chemico-magnetical experiments*; because the greatest part were performed by the help of the fire, or bodies chemically prepared by the application of it. And because it is usual, with the best writers about magnetism, to reckon steel and iron among magnetical bodies; I shall not scruple to deliver in this paper some experiments made by the help of the fire upon those subjects, with reference nevertheless to magnetism.

EXPERIMENT I.

HAVING ignited several loadstones, and removed them from the fire till they grew cold again, I found a great disparity in the visible substance whereof they consisted, and the manifest structure of the gross parts that made them up. For some stones, upon refrigeration, either fell asunder of themselves, or grew very brittle, whereas others still continued in their entireness: some of them, being broken, looked not unlike iron-ore, or stones which I have gathered near iron-mines in *Kent*; others, being broken after refrigeration, appeared to consist of plates or flakes of several colours, and lying parallel to one another; and others again, which as I remember were English ones, did neither appear to be composed of any such flakes, nor had their dark colours much, if at all, changed by the operation of the fire, nor did cease to be solid bodies.

EXPERIMENT II.

WE could not, upon the burning of several small loadstones one after another, discern any such blue sulphureous flame as *Porta* in his natural magic relates himself to have seen, and judges to have been, as it were, the soul of the loadstone; upon whose recess, he says, it lost its magnetic faculty, which is most commonly true as to any considerable degree of the coitive or attractive power, but not of the directive.

rective faculty or virtue. But it may be, that *Porta* mistook the small flame, which is often emitted even by well-kindled and glowing charcoals, (on which sort his loadstone was placed) especially when a little blown upon, for the exhaling soul of the loadstone; or else, to be civil to him, we may suppose, that his stone was more rich in unctuous moisture than others are wont to be; and, if we had had by us a very exact pair of scales, we should have endeavoured to have by them discovered, whether the fire do deprive loadstones of any ponderous parts. See Experiment. II.

EXPERIMENT III.

THE solidity of some English loadstones made me think it fit, though I looked upon them as a kind of iron-ore, to try whether they could not be brought to strike fire. And accordingly, having made divers collisions betwixt a rough piece and the steel of a tinder-box, I found, that with much ado it was possible to obtain some sparks, (though they seemed but small ones): but, having taken a large piece of smooth loadstone, I found, that, by striking it somewhat briskly with the edge of a steeled hammer, we were able to produce good store of sparks, and some of them of a surprising bigness, for they were judged to exceed the size of those, that are usually afforded by common flints.

EXPERIMENT IV.

FOR certain reasons I thought fit to make a further trial, being desirous to satisfy myself, whether it were not possible to make loadstones afford fire without the help of iron or steel. And being willing to comply with this curiosity, I made choice of two solid pieces of loadstone, that were cut almost into the form of cubes; and found, that many collisions being made between them, especially at the edges, there were produced, from time to time, (though not frequently) some sparks of fire, though neither so numerous, nor so great or vivid, as those of the foregoing experiment, wherein the steel was employed.

EXPERIMENT V.

I HAVE (elsewhere) formerly related, that, if an oblong loadstone (made glowing hot) be refrigerated perpendicularly, the lower extreme will thereby become its northern pole. And I shall now add, that yet if such a loadstone be refrigerated perpendicularly, not upon an ordinary terrestrial body, but upon the northern extreme of a much stronger loadstone; in such case, this debilitated stone will receive its impressions, as if it were an iron, and its lower extreme will not be, as before, by the magnetic effluvia of the earth, made its northern pole; but it will be contrariwise animated by the pole of the loadstone, on which it is cooled; and, according to the laws magnetical, the lower extreme of it will not be its northern (but its southern) pole, nimblely attracting the north end of an excited and æquilibrated needle.

EXPERIMENT VI.

By the forementioned way of refrigeration I also found, that a disanimated loadstone (if I may so speak, may be restored to some degree of its attractive virtue; for I tried, that a small loadstone, which after its being made red hot in the fire, and cooled perpendicularly upon the ground, was not able to take up a fragment of a needle, being again heated, and not only cooled upon the pole of a strong loadstone, but suffered to rest on it a while after, was soon grown vigorous enough to take up what formerly it could not move.

E X P E R I M E N T VII.

I FURTHER observed, that though a loadstone, that had passed the fire, had not, by being immediately before made red hot, had its body opened, and fitted to take in plentifully the magnetical streams; yet it would, like a wire of iron, acquire a new verticity from the vigorous loadstone, but not be in many hours so vigorously impregnated with magnetic virtue, if it were applied cold to the pole of the animating loadstone, as it would in a very short time, if, being glowing hot, it were refrigerated thereupon.

N. B. It has been observed, that, if a loadstone be made red hot in the fire, it will scarce retain any sensible attractive virtue, save that it will be able, by being endowed with a magnetism from the earth, to drive away that pole of a needle well poised, which agrees in denomination with that pole of the loadstone, which is applied to it. But I desire, that it may be remembered, that I intimated, that this is not strictly and universally true; for in some of our English loadstones it has been observed, that ignition does not only leave them capable of a directive virtue, but leaves them also a considerable attractive power, so that they will sustain a good weight of steel, as will appear hereafter.

E X P E R I M E N T VIII.

WE took three English loadstones, that appeared to be of a very compact substance; two of them very small, as not being of near half an inch in length; the other much greater, being about an inch long, and of a considerable breadth, but yet of small thickness: these we made red hot in a fire of well-kindled charcoal, and, being thoroughly ignited, removed them one after another, and hastily set each of them upon a plate of silver, (for neither wood nor iron would have been convenient) and applying the loadstone (capped) to each of them, whilst it was yet red hot; it seemed manifest enough, not only that, whilst it was in that state, the stone had not so strong an operation on it, as if it were not red hot; but, which is remarkable, when it ceased to appear ignited, but yet was intensely hot, (so that it was readily able to burn his fingers, that should offer to take it up between them) the armed loadstone had a more powerful operation on it, by way of what they call attraction and sustentation, not only, as I said, than it had, whilst the ignited stone conspicuously retained the colour of fire, but than it had after the same stone was grown cold.

E X P E R I M E N T IX.

THIS experiment was reiterated with the two smaller magnets, and the greater with the like success; and when the magnets were grown cold, they did, notwithstanding their having been twice ignited, discover some little magnetism, if applied to the end of a well-excited magnetic needle, nicely poised upon the point of an ordinary needle [or brass pin] on which its center of gravity leaned. And I found, that the bigger of the three forementioned loadstones, after the first (if not also after the second) ignition, did not only move the magnetic needle more briskly than one would have expected, but, (which may seem strange) being thrust into filings of Mars, and then taken out, it carried up with it (and sustained) a considerable number of them. Whence we may conclude, that in some loadstones of a very solid constitution, such as this was, the magnetical virtue is more radicated (if I may so speak) or permanent, than in the generality of other magnetics; this stone being the first, wherein I observed, after I had thoroughly ignited it, any attractive virtue able to take up filings of iron.

E X P E.

EXPERIMENT X.

ON occasion of these trials I made another, which, though to some it may seem but slight, I thought the more worthy to be made, because I remember not to have read or heard of it before: we took then the same loadstone, that we employed about the last experiment, and, having again made it red hot in the fire, suffered it not to cool leisurely in the air as before, but quenched it in a basin of cold water, intending thereby to make a double variation of the experiment; first, by cooling it hastily, and as it were abruptly; and next, by cooling it, not in the air, but in a fluid some hundreds of times more dense or ponderous than the air. The event of the trial was, that, upon the immersion of the red hot stone, there fell off some flaky matter, as if it had been scales of Mars; and the stone, when cold, would not take up any filings of iron, as before it did many; so that it appeared to have lost much of the virtue it so lately had, though it retained the power to move a well-poised needle, if it were held near to either side of the point of it.

EXPERIMENT XI.

A BLACK oblong loadstone, of a homogeneous substance, and weighing near three drachms, having been in a fire of well-kindled charcoals ignited, and continued so for some minutes of an hour; being weighed again as soon as it was cooled, was found to have lost about $\frac{1}{5}$ of a grain of its first weight, and much of the blackness of its colour.

THOUGH the affinity between the loadstone and iron might make one expect, that the fire might have a like operation upon this stone, and that out of which iron is commonly melted, both being indeed iron-ores; yet for some reasons, that I cannot now stay to mention, I was induced to think, that the effect of ignition upon those two bodies might be very differing, as I conceive their internal and unseen texture to be. And therefore I made the following experiment.

A LUMP of iron-ore, which looked almost like a white stone, rather than a common ore, and was about the bigness of two eggs, being applied, in several of its parts, to an excited needle, did not appear to move it manifestly. But being afterwards made glowing hot, and kept so for a while, and then refrigerated, it did in those parts, which seemed by their newly acquired colour to abound with metalline corpuscles; it did, I say, manifestly attract the north end of the needle. And this was tried, both with a needle of our own touching, and by the mariner's needle of a sun-dial, whose flower-de-luce the burnt ore did manifestly draw.

EXPERIMENT XII.

To confirm the former observation, and also what I elsewhere gave notice of, that divers bodies are of a magnetical nature, or have in them some parts that are so, which yet are not vulgarly believed to be referable to that sort of bodies, I shall subjoin the following experiment.

A BRICK, that had not been used, was sawed long-ways into two equal pieces, and each of these (one at one time, and another at another) was heated red hot in the fire for a pretty while, and afterwards suffered to cool north and south: and, as I expected, it thereby acquired a magnetical verticity; and with that end, that in cooling respected the south, did a little, though but faintly, draw the flower-de-luce (which pointed out the north) of the mariner's needle; and with the other end did somewhat more vigorously drive the flower-de-luce away, and a little attract the other extreme of the needle.

E X P E

E X P E R I M E N T XIII.

WE took a [black] loadstone, and having by degrees beaten it small, without suffering it to touch any iron or steel vessel, or instrument, [which, because of the hardness of the stone, was very troublesome to do]; we set aside the grosser grains for other uses, and upon some of the finer powder we poured the spirit of common salt, which had at first a sensible operation upon it, by producing foetid fumes, and making a kind of ebullition, as that menstruum is wont to do upon filings of iron or steel. But nevertheless, being kept a night or two in digestion, it drew a high tincture; and though this was not at all like the solutions of Mars in spirit of salt, green, but of a yellowish brown, not very remote from redness; yet a little of it, being dropped into a fresh and sufficiently coloured infusion of galls, turned it presently into an inky substance, which in some positions appeared blueish, as a tincture or light solution of Mars would have done. I shall only add about the solution of loadstone, that, having carefully made it with a good aqua regia, I obtained a solution, some of which you may yet command a sight of, that by some virtuosi, to whom I shewed it, was thought either a fine solution of gold, or little, if at all, inferior to it in kind or richness of colour. I chose to employ the spirit of salt, rather than that of nitre or aqua fortis, in this experiment; because I found the first named liquor to dissolve iron very well, if not better, though less furiously, than aqua fortis itself; and also, because I could by this means better judge of the tincture of its colour, having formerly found by trial, that spirit of salt makes a green solution of Mars, but aqua fortis, or spirit of nitre, a reddish one. And it was to judge of the tincture of the loadstone, as well as for another purpose, that I was so careful to keep the stone from touching iron, when it was pulverising, lest by the hardness of it, and the sharpness of its angles, it should grate off some parts of the metal, and so alter the solution; for want of which caution, I have known some experiments about artificial gems to miscarry; the brass mortar, wherein the hard ingredients were beaten, having communicated some particles to them, that altered the colour, which the mass after vitrification would otherwise have been of.

E X P E R I M E N T XIV.

SOME parts of the foregoing experiment may be confirmed by that which follows.

I CAUSED a weak loadstone to be heated red hot, to make it the more easy to be powdered; and, having caused it to be beaten very fine, I digested good spirit of salt upon it. (I afterwards found, that ordinary spirit would serve the turn.) This in a few hours acquired a tincture not greenish, but almost like that of a troubled solution of gold. It strongly relished of iron, and a little of it being dropped into infusion of galls, it turned it immediately into an inky liquor: part of this solution, being gently evaporated, grew thick like an extract, but did not seem disposed to shoot into crystals; yet another part of it did precipitate with salt of tartar, much like a solution of vitriol; and another, with spirit of fermented urine, gave a plentiful but yellowish red precipitate.

E X P E R I M E N T XV.

MEETING, among my loose notes, with one, that may serve both for a variation and confirmation of what has been above delivered in the experiments; it seemed not improper to annex a transcript of it.

A RED mineral, whose consistence was between stony and earthy, was by me judged to be a kind of iron-ore; though, having powdered some of it, I could not find, that

that a good loadstone would attract any part of it: therefore, to satisfy myself, and to confirm *D. B.*'s observation about the virtue of linseed-oil, I caused this red powder, wetted with that liquor, to be kept about two hours ignited in a crucible, by which means it was turned blackish. This dark-coloured powder was taken out, and suffered to cool, and then would readily adhere to the same loadstone, almost as if they had been a heap of filings of iron. But the operation of the fire perhaps contributed as much (or more) as the linseed oil to this change. For a parcel of the red powder, being kept ignited in a crucible, though without the liquor, did afterwards appear magnetical.

AFTER having said thus much of the most useful of uncommon stones, the magnet; it will not, I presume, be thought incongruous to subjoin some remarks about the most precious of them, that are known among us, *viz.* diamonds, which will be done in the next chapter.

C H A P. II.

Containing various Observations about Diamonds.

DIAMONDS being generally esteemed the most noble and precious of gems; and even of inanimate bodies here below, (for of carbuncles the very existence is disputed); the opportunity I had of being one of the committee or directors of the English *East-India* company (whereto the desire of knowledge, not profit, drew me) allowed me in some measure to gratify my curiosity about them, by adding, to some observations of my own, the answers I had to the questions I propounded to some *East-India* merchants and jewellers, that had opportunity to deal much with those gems. Part of what I had learned about them I committed from time to time to some papers, which were the main things that supplied me with the following particulars.

THESE gems (to add that upon the by) may the rather deserve our curiosity, because the commerce they help to maintain between the western and eastern parts of the world is very considerable. For, as small as their bulk is, their properties and men's opinion do so much recommend them, that I remember one of the most famous and intelligent merchants of this nation (who has been governor of more than one trading company in it) being enquired of by me about the value of the diamond trade; he answered me, that year, according to his well-grounded estimate, there came from the *East-Indies* into *Europe*, one with another, to the value of about 350000*l.* sterl. of which about 100000*l.* came into *England*, which at present; because of the prudent indulgence of the government, and of the *East-India* company, is become the mart of diamonds.

I. To prove the great hardness of diamonds, even in comparison of other bodies; that are thought wonderfully hard, a famous artist for cutting of diamonds, in return to some questions I put him, affirmed to me, that he could not either cut or polish diamonds, with any thing but with diamonds. And he further answered me, that if he should employ so rough a way; and such forcible engines; to cut rubies or any other stones, as he does to cut diamonds, it would presently break them in pieces: which the inspection of his engine made very probable to me.

II. A VERY skilful cutter and polisher of diamonds (*Mr. L.*) being demanded by me, whether he found, that all sorts of diamonds were of equal hardness, told me, that, having dealt in diamonds near twenty years in *Amsterdam*, and divers years in *England*, he perceived, that there are, of later years, brought over worse and worse sorts of diamonds; so that he judges those of the old rock (as he calls them) either

to be quite spent in the *Indies* themselves, or at least to be seldom or never brought over to us. And he finds several of recent diamonds so soft and brittle, in comparison of those of the old rock, that he is oftentimes afraid, or unwilling, to meddle with them, lest he should spoil them in the cutting or polishing.

III. NOTWITHSTANDING the (lately mentioned) wonderful hardness of diamonds, there is no truth in the tradition, as generally as it is received, that represents diamonds as incapable of being broken by any external force, unless they be softened by being steeped in the blood of a goat. For this odd assertion I find to be contradicted by frequent practice of diamond-cutters: and particularly having enquired of one of them, to whom abundance of those gems are brought to be fitted for the jeweller and goldsmith, he assured me, that he makes much of his powder to polish diamonds with, only by beating broad diamonds (as they call them) in a steel or iron mortar, and that he has that way made with ease some hundreds of carrats of diamond dust.

IV. IT is an opinion received among many, that deal in gems, that as diamonds are the hardest of bodies, so the same compactness, and their great solidity, gives them also a proportionable gravity, and makes them extremely weighty, in reference to their bulk: and I saw, in the hands of a virtuoso, a book (that I could not procure) not long since put out by a French jeweller, who, as he affirms, has dealt very much in diamonds; wherein the author asserts the great ponderosity of these stones, in comparison of other bodies. But this opinion agrees very little with the following experiment, that I find (among others, that I tried about gems) registered to this purpose.

A ROUGH diamond, somewhat dark within, did, in a pair of scales that would turn either way with the 32d part of a grain, weigh eight grains, and eight sixteenths. This stone being with care weighed in water, according to the rules of the hydrostatics, its weight appeared to be, to that of an equal bulk of that liquor, as $2\frac{2}{3}$ to 1. So that, as far as can be judged by this trial, even a diamond weighs not full thrice as much as water.

V. A FAMOUS and experienced cutter of diamonds, being asked by me, whether he did not find some rough diamonds heavier than others of the same bigness, told me, that he did, especially if some of them were cloudy or foul: insomuch that, shewing me a diamond, that seemed to be about the bigness of two ordinary peas, or less, he affirmed, that he sometimes found in diamonds of that bigness, compared together, about a carrat (or four grains) difference in point of weight.

VI. THE shape or figure of diamonds is not so easy to be securely determined. For those, that are seen in rings and other jewels, having been, by way of preparation, cut and polished, have changed their natural figures for that, which the artificer thought fit to give them. And rough diamonds themselves (which are not obviously met with) do oftentimes come to our hands broken, though unwillingly, by the diggers: and thereby unfit to acquaint us with their genuine shape, which we may also miss of being able to discover, on account of the accidents, that the matter they consisted of was subject to, at their formation in the mine. For, to omit other proofs, having had a parcel of between 100 and 150 (if I misremember not the number) put into my hands at one time in the East-India house, to gratify my curiosity, I found very few of them compleatly shaped; but most of them broken, and of very irregular figures, like those of so much gravel taken up at adventures upon the sea-shore. But some few I saw, that were pretty regularly figured, which probably were not much hindered from shooting freely in the wombs or cavities, wherein they were coagulated or concreted. And these seemed to consist, in my opinion, of several triangular surfaces, that were terminated in (or composed) divers solid

solid angles. And one rough diamond I had of my own, wherein this shape was more conspicuous than I remember to have seen in any other. Besides having enquired of a very experienced artificer, who dealt much in fitting these gems for the goldsmiths use, whether he found rough diamonds to be of any constant figure, and if he did, what that figure was? he answered me, that he always found those, that had any constant (or, as he meant, regular) figure, to be, in his own expression, fix cornered.

VII. DIAMONDS have in them a grain (or a determinate tendency of their fibres, or rather of the thin plates they are made up of) as well as wood, and may with ease enough be split along the grain, though not against it; as I have seen a very large diamond, that was cut according to the grain into three pieces, whereof the middlemost, though large, and about the thickness of a shilling, was of an even thickness, and exactly flat on both sides. I have myself a diamond ring, whose stone I would not have polished, but caused it to be set rough as nature produced it, because in that state the grain is manifest to the naked eye, and much more to a glass moderately magnifying the several plates it consists of, having their edges distinguishable, like those of a book a little opened. A cutter of these gems, that has had store of them to practise his skill on, answered me, that one good blow may split even great diamonds, if it be given, as they speak, with the grain; but against the grain, he affirmed to me, as dexterous and expert an artificer as he is, that he is not able so much as to cut or polish them.

VIII. THE common colour of diamonds being generally enough known by sight, it is not needful, as it would not be possible to describe it by words; but the most usual colour of these gems is not the only, of which they may sometimes be found. A great traveller into the eastern parts of the world assured me, that he had seen some of them, that were of a pale bluish colour. That famous French jeweller as well as traveller, Monsieur *Tavernier*, gives an account of a fair diamond that he had of a very red colour; and that great ornament of our English court, the D. of R. told me, that she was mistress of a fair one, which, though not of a ruby, was of a red colour, but not having it at hand, she could not then shew it me. A relation of mine, in the same court, used to wear a diamond ring; which though the stone was not great, he valued at a hundred pound, because its colour was of so fine a golden yellow, that I should have taken it for an excellent topaz, but that he had satisfied me it was a diamond, to which agreed its great hardness, which gave an uncommon lustre. And I remember, that surveying attentively a parcel of rough diamonds newly brought from the *East-Indies*, I perceived among them, besides several lighter variations of colour, one stone, that was all green, and that to such a degree, that I doubted not, that if it were polished and set, it might pass for an excellent emerald; and I should have suspected this gem to have been really of that kind, but that I found it among diamonds, that belonged to merchants too skilful in those gems to be imposed upon; and, which was more, the stone being yet rough and uncut, I found it plainly to have the proper shape of a diamond.

IX. AT the late return of the ships from *India*, being present at the delivery of the diamonds to the owners, I observed one belonging to a Dutch merchant, whose father was a cutter of diamonds, and bred him to the same trade. The diamond came from the king of *Choleconda*; it was shaped (like mine) with six triangular sides, which yet were neither regularly figured nor truly flat, some of them being a little convex, and one of them having a manifest and oddly-figured cavity in it. But the diamond being fair and flawless, and so thick, that the merchant told me it would be too deep for one ring, and that therefore he meant to split it into two; I had it weighed, and

found it to amount to ten carats (or 40 grains.) I could easily perceive the grain of this diamond, which the merchant also acknowledged; who answered me, that he had never seen in diamonds any heterogeneous mixture enclosed. He further informed me, that there was brought him a large diamond from *Borneo*, that was much darker than one I shewed him, insomuch that he compared it to foot; but when he had cut and polished it, he and others were much surpris'd to find it a fair and clear stone, of very great value.

X. THE conjecture I have elsewhere propos'd, that divers of the real virtues of gems may be probably derived from the metalline or mineral tinctures, or other corpuscles, that were embodied with the matter of the gem, whilst it was yet fluid or soft, and afterwards concoagulated therewith: this conjecture, I say, may be much countenanced by the following relation, which deserves a place in this chapter, by reason of its pertinency to the subject of it.

I HAVE long suspected, that the matter, whereof diamonds mainly consist was, whilst it was yet *in solutis principiis*, impregnated with metalline, and more particularly with martial ones: but by reason of the dearth of those gems, and some other impediments, though I have been master of differing sizes, cut, and uncut, yet I could never make a trial capable of satisfying my curiosity, till having lately met with, among other curiosities that lay long neglected by me, some number of small diamonds, that I had bought for experiments; I consider'd, that their being yet rough, and so in their natural state, might make them more fit for my purpose, and so it might, that they were not so clear as those, that we value in rings, which probably argued their having more of martial tincture in them than I should expect in the more diaphanous: upon this account, I say, I took a moderately vigorous loadstone, (for it was none of the strongest I have had) and applied it successively to five or six of these small stones, without perceiving it had any operation on them. But when I came to apply it to one more, which looked somewhat duller than almost any of the rest, I found, that it had in it particles enough of an iron nature to make it a magnetical body; and observed with surpris'e, that not only it would suffer itself to be taken up by the strongest pole of the loadstone, but when that pole was offer'd within a convenient distance, it would readily leap through the air to fasten itself to it.

I HAVE elsewhere mentioned some other qualities of diamonds, as besides their electrical virtue, this, that it is possible, that some of them may without fire or intense heat be brought to shine; though among all that I have tried, I found but two, that I could so make luminous. One of these belongs to the king, and is described at the latter end of our *History of colours*; and the other is a very small one of my own; which either was quickly lost among other stones of the same size, or quickly lost its faculty of shining. But to avoid repetitions, I shall here only add, that some few other observations, of a more particular sort than those deliver'd in the two foregoing pentades, may be found in other writings of ours, to which they seem more properly to belong.

C H A P. III.

Many changes of colour produced by one simple ingredient.

I KNOW not any way more likely to convince the generality of men, (who are wont to be much more impress'd on by sensible phænomena, than theories, though solidly founded) how great an interest the variable texture of bodies may have in making them appear of differing colours, than by shewing, how the addition of a single ingredient,

ingredient, that either is colourless, or at least is not of any of the colours to be produced, is capable (and that for the most part in a trice) by introducing a secret change of the texture to make the body, it is put to, appear sometimes of another, according as the parts of the body wrought upon are disposed to receive such a change, as modifies the incident beams of light after the manner requisite to make them exhibit a blue, a green, a red, or some other particular colour.

UPON this consideration I thought of several liquors, such as aqua fortis, oil (as they call it) of virriol, or instead of it sulphur, aqua regia, besides other saline liquors, that I shall not now stay to name, because it may here suffice to tell you, that amongst them all I made choice of the spirit (not that, which chemists call the oil) of salt, as that which is very simple, and which, if it be not too much dephlegmed, may be had clear and colourless enough. With this spirit I proceeded to make the following experiments upon several bodies, whose differing textures made me suppose, they would be fit for my purpose. And though I could not, without much disadvantaging my design, forbear to mention some trials, that may be found elsewhere scattered among my writings on other occasions; yet the greatest part, by odds, of those laid together in this chapter, will, I presume, be found new.

I. SOME drops of well coloured syrup of violets being let fall together upon a piece of white paper, if a third or fourth part so much spirit of salt be with the tip of one's finger mixed with them, the syrup will presently become of a red colour, usually somewhat inclining to purple.

II. BUT if the liquor to be acted on be otherwise disposed, it is possible with spirit of salt to turn it from a blue colour, not to a red, but to a green, as I have sometimes done by letting fall into a deep solution of filings of copper made with an urinous spirit, as that of sal armoniac, just as many drops of spirit of salt, as were requisite and sufficient to produce the change intended. I say just so many drops, because a very small error, either in excess or defect, may leave the mixture still blue, or bring it to be all colourless.

III. UPON a quantity, not exceeding many drops of good syrup of violets, let fall two or three drops of good spirit of urine, hartshorn, or the like, or of oil of tartar, *per deliquium*; and by mixing them well, the syrup has acquired a fine green colour, then by putting to it a little of the spirit of salt, and stirring it with the tip of your finger, you may turn the green syrup (as in the first experiment you did the blue) into a red.

IV. IF you put a quantity of red rose leaves well dried into a glass vial almost full of fair water, and soon after put to them as much spirit of salt, as will make the water pretty sharp, you will quickly see, both that liquor and the contained leaves brought to a fine and lovely red, which scarlet colour it will retain for a great while. The like effect spirit of salt will have on some other vegetables of a stiptic or of an astringent nature.

V. BUT if by infusing brasil in fair water, you make a tincture of it, which you may much deepen by dropping into it a little spirit of harts-horn, or of urine; if you then put to it a little spirit of salt, it will presently change it from a deeply reddish colour, oftentimes like that of muscadine, to a colour far more pale, or rather yellow, like that of the more dilute sack; so that the same spirit acting upon two vegetable tinctures differently disposed, draws out and heightens redness in one, and destroys it in the other.

VI. IF you make an infusion of true lignum nephriticum in spring water, it will appear of a deep colour, like that of oranges, when you place the vial between the window and your eye; and of a fine deep blue, when you look on it with your eye

placed

placed between it and the window. But if you shake into this liquor a few drops of spirit of salt, the ceruleous colour will presently vanish and appear no more, in what light soever you look upon the vial, though the liquor will still retain the orange colour.

VII. WE took common writing ink, and having let fall several drops of it upon a piece of white paper, so that when it grew dry in the air, some parts of the ink lay thick and some thinner upon the paper, whereon it did spread itself, we put a few drops of strong spirit of salt, some on one part of the blacked paper, and some (or perhaps a small drop) on another, and observed, as we expected, that in these places, where the spirit had been put, or to which it reached, the blackness was quite destroyed, and succeeded by an unpleasant kind of colour, that seemed for the most part to participate of yellow and blue, neither of them good in its kind.

VIII. If in spirit of salt you dissolve filings of steel, and slowly evaporate the filtrated solution, it will shoot into a kind of vitriolum martis, that will be green, as well as that which chemists vulgarly make with oil of vitriol. And to add, that on this occasion, if you take these crystals made with spirit of salt, and when they are dry, keep them in a crucible, you will find, that even a moderate fire, if duly applied, will make them in a short time exchange their green colour for a red, like that of the finer sort of crocus martis, as indeed this operation makes them referable to that sort of medicines.

IX. WE took some mercury precipitated, *per se*, (that is, by the sole action of the fire, without any saline additaments) and though crude mercury is not, as far as I have tried, soluble in our English spirit of salt; yet this red precipitate (which is supposed to be mere mercury) with its own sulphur extraverted, did readily enough dissolve in that liquor, and, if I very much misremember not, did not at all impart its own colour to it: and I also found, that red lead or minium being boiled a while in good spirit of salt, the redness did totally disappear. So that the same agent, that produces redness in divers bodies, did in those two, I have been mentioning, more than change it, since it quite abolished it. Of which also I can give you an easier instance, by observing, that the reddest coral being dissolved in our menstruum, the redness vanishes, and the solution appears colourless.

X. TAKE filings of copper (the smallest are the fittest for this experiment), and having poured on them good spirit of salt till it swim about two fingers breadth over them; keep the vial in a pretty strong heat (in a sand furnace) till you perceive the menstruum has dissolved a competent part of the metal: then warily take out the vial, and holding it between your eye and the light, you will perceive the solution of copper to be not like that of steel formerly mentioned, of a green colour, but of a dark and troubled one, oftentimes inclining to a deep, but muddy red.

XI. BUT if you pour this solution into a wide-mouthed glass, and let it stand for a competent time (which sometimes amounts but to a few hours, and sometimes to very many) the exposed liquor will appear of a green, much finer than that of the crystals of Mars.

XII. TAKE filtrated and limped solution of silver, or of mercury made in aqua fortis, and drop upon it some spirit of salt, by which you shall find the clear liquor turned white as milk, which after a while will let fall a precipitate of the same colour.

XIII. AND if, instead of a solution of silver, or quicksilver, you take a red solution, or tincture of Benjamin, or of the resinous part of jallap root, or you will also have, upon the affusion of spirit of salt, a white liquor and a precipitate of the same colour.

XIV.

XIV. BEING desirous to produce two differing colours at once by the same affusion of spirit of salt, I infused some dried red rose-leaves in fair water, till it had acquired a deep colour from them. To this infusion, poured off warily, that it might be clear, I added a considerable proportion of the sweet liquor, made by digesting spirit of vinegar upon red-lead, by which I knew it would be turned of a blueish green. Upon this almost opacous liquor I poured spirit of salt, which, as I expected, precipitated the lead, that had been dissolved in the sweet liquor, into a very white powder, and gave the remaining liquor, well impregnated with particles of the rose leaves, a very fine and durable scarlet colour. To which experiment I shall add on this occasion, that, if it had been well made, you may barely by shaking very well together and confounding the white powder with the red liquor, make a carnation colour, which (when it is made as it should be) appeared very fine and lovely whilst it lasted, for in no long time the two substances, that composed it, would by degrees separate, and re-appear each of them in its former place and colour.

XV. WE took some spirit of salt, that having lain long upon filings of copper, had lost the muddy tincture it had first acquired by being almost boiled upon them. This liquor, I say, that looked like common water, we poured into a small, but wide-mouthed crystal-glass, about half an hour after 8 in the morning, and leaving it in a window, it appeared after 40 minutes to have there acquired a colour, much like that of a German amethyst, and seemed to have no tendency to greenness. But being detained by the visit of a virtuoso till eleven a clock, I could not see what happened in the mean time: but then, as he was going away, I invited him to see the liquor, which he (not knowing what it was) told me it looked of a grass-green colour; wherein, though I were not altogether of his mind, yet in a short time after, it did to me also appear of a lovely green; in its passage to which it had in all been exposed about three hours and a half.

XVI. PRECIPITATE a strong solution of sublimate (made in fair water) with a sufficient quantity (and no more) of oil of tartar *per deliquium*. Put the liquor and powder into a filter of cap-paper, and when the water is run thorough, there will remain in the filter the precipitate, which is to be slowly and well dried. Then take it out of the filter, in the form of a gross powder, and having put it into a clear glass, let fall on it warily some drops of pretty strong spirit of salt, and (if the experiment succeeds with you as it did with me) during the conflict that will be made, the little lumps of the precipitate will lose all their former brick-dust colour, and turn white, though afterwards they will appear dissolved into a transparent liquor, wherein the orange colour is quite abolished.

XVII. HAVING calcined copper without any additament, save fire and water (by the way we elsewhere mention) we took an arbitrary quantity of it, and having poured on it about 3 or 4 times the quantity of good spirit of salt, we obtained (what we looked for) both a muddy, but manifestly reddish liquor, and (somewhat to the surprise of the persons I had a mind to satisfy) a white powder, whose quantity bore a considerable proportion to the part, that was dissolved (but whose qualities belong not to this place.) In which part its self (to add that upon the by) by the affusion of common water, and the action of the air, we afterwards produced more than one change of colour.

XVIII. WE sometimes for curiosity sake took a quantity, not exceeding a spoonful, of the dark brown or somewhat reddish solution of §, mentioned in the foregoing experiment; and having put it into a cylindrical vial, that the change of colour may appear the better, we poured on it 2 or 3 spoonfuls of totally ardent vinous spirit; and giving the glass a shake to mingle them, we presently had (as soon as the mixture

mixture became clear) a lovely green liquor, which, when it was well settled, was very fair, and looked almost as if it were a liquid emerald.

XIX. WE took some green taffatee ribband, and having moistened one part of it, that was not great, twice or thrice with good spirit of salt, we suffered it to dry of its self; which it did in a short time, and then we found, as we expected, that the wetted part was no longer of a green, but changed to a blue colour. But the same spirit (to add that upon the by) presently turned that part of a piece of black ribband, upon which we put 2 or 3 drops of it, to a colour not unlike that, which they call *feuille morte*, or, a fading leaf.

XX. IT is usual in paper-shops, and in divers other places, to meet with pamphlets and other thin books, that are covered with papers, that look sometimes of a greenish blue colour, bordering upon purple, and sometimes upon that of violets. Some of the deeper coloured papers of this sort I have several times, to gratify some curious persons, especially of the sex, held in my left hand, and with the other lightly and nimbly touched them here and there with the end of a feather (cut off from the rest of the quill) dipt in spirit of salt, which almost in the twinkling of an eye, dyed the touched parts of the paper with a lovely red, that would sometimes continue very vivid for a good while, and be manifest at the end of divers weeks, if not months. And if instead of the forementioned quill, I took into my right hand (a brush, or) somewhat that was fit to sprinkle with, and having dipt it in the saline spirit, made many drops at once fall upon the paper, it was pleasant enough to behold, how suddenly and prettily it would be speckled.

XXI. WE took antimony well powdered, and poured on it three or four times its weight of good spirit of salt: we caused it to be boiled in this liquor (and that in a glass vessel) wherein a part of it was dissolved, and taken up into the menstruum; where the antimony quite lost its blackness. And this thus impregnated spirit of salt being dropped into fair water, the black mineral subsided immediately in the form of a very white powder or precipitate.

To these I might add other changes of colours, that I have made by the help of spirit of salt. But these being not of so quick and easy trial, (especially because some of them require skill in chemistry) I thought it not fit to annex them, supposing, that those already delivered, amounting to above four pentades, may suffice for the purpose declared at the beginning of this paper. And also to afford us this reflection, that it may not be amiss, if physicians, chemists, and others, that are wont to compound drugs or other ingredients, would be less forward, than they usually are, to mingle, not to say to jumble several of them together, either unnecessary, or without due regard to the friendly and incongruous qualities, (in reference to one another) that the separate ingredients may have. For most of us are but too liable to be mistaken, when we presume before-hand, what changes the coalition, or other associations, of differing bodies may produce, especially if they be either saline, or plentifully partakers of a saline nature; since experience frequently shews, that by the action and re-action, that are consequent upon untried ways of composition, there emerge in the mixture new consistencies and other qualities or accidents, that were not looked for, when the ingredients it is compounded of were put together. And though it may sometimes happen luckily enough, that these emergent qualities, whether of drugs, or other comparatively simple bodies, may prove advantageous; yet this may well be looked upon but as a lucky chance, and hinders not, but that one may justly fear, that ordinarily the newly produced quality of a medicine may prove to be either worse than was expected, or at least other than was designed, and consequently less fit for the physician's or the artist's determinate purpose.

C H A P. IV.

An Advertisement touching those Passages, that in this Book relate to the Art of Medicine.

THE favourable reception the public was pleased to give two editions set forth in one year of *The Usefulness of experimental Philosophy*, having encouraged the stationer to solicit me for a new impression, I was on the same ground invited to think of making additions to divers parts of that treatise. But afterwards observing, that notwithstanding the thanks and acknowledgments I had the good fortune to receive from several physicians, some of them of great reputation, (and perhaps by that only known to me) yet others were not well pleased, that a person not of their profession should offer to meddle with it, though with a design of advancing it; I, whose condition exempted me from taking upon me their calling, and who consequently must want many opportunities, that others enjoyed, of making observations about the phænomena of diseases and of medicines, suffered myself without much violence to be diverted to other studies more suitable to my inclinations, as well as to my condition; and accordingly I laid aside the papers I had written in reference to the physician's art; nor were it easy, or perhaps possible for me to retrieve them, after they have lain so many years dispersed and neglected, by which means perchance divers of them have been lost.

BUT all this could not hinder me from being pressed to retrieve and communicate these scattered and dusty papers by the secretary of the Royal Society, Mr. *H. Oldenburg*: for as this gentleman has been almost every where wonderfully solicitous to preserve every thing from being lost, that may any way contribute to encrease the stock of useful knowledge; so having got notice of these papers, and a sight of some of them, his partiality for me made him much over-value them, and persuaded him, that a collection of them, as incoherent and unfinished as they were, might be of some use to the physician's art. And this seemed the more hopeful, because natural philosophy being a science of far greater extent than physic, and supplying it with many of its principles and theories, it is very possible, that naturalists, though not professed physicians, may propose some such comprehensive notions and methods, as may awaken and enlarge the minds of them that are so, and at least afford some useful hints to considering and ingenious men. And in effect divers physicians, as well as many patients, have been pleased to declare (some in print, and some other ways) that sometimes they found not useless assistances from some of those papers, wherein I occasionally touched on medicinal things. Such motives as these made Mr. *Oldenburg* so earnest to procure the scattered fragments, that I might have yet remaining, about medicinal affairs; that though for the reasons mentioned above, I could not think it fit to make a collection of papers so unlike in their subjects, so disproportionate in their bulk, and so unfinished and imperfect on divers scores; yet thus far I was content to comply with his desires, that when these trifles came to hand, I would now and then insert them among my *Experimenta & Observationes Physicæ*, (medicine being a part, or an application of natural philosophy;) especially if there were any great affinity between the paper I lighted on, and the subject I was then treating of; knowing well, that Mr. *Oldenburg*, and perhaps some others too, had rather I should impart them at all adventures, than suppress what they judged might be useful; and that it was better to run the hazard of having them slighted, than lost.

THIS advertisement I thought fit to give in this place, once for all, that when hereafter

after there shall occur any thing among these *Experimenta & Observationes Physicæ*, that directly relates to the physician's art, you may not think it strange, remembering upon what account I ventured to meddle with things of that nature, and also that you may readily understand what I mean, when you meet with any particulars delivered, as thoughts, or desiderata, or wishes, tending to, or aiming at the improvement of medicine; which how slight or superfluous soever they may be to experienced masters, to whom I did not presume to recommend them, I thought might probably be serviceable to a very ingenious, but yet young cultivator of that noble art, (whose name I concealed, after the way of the curious of *Germany*, under that of *Trallianus*) for whose use they were intended.

The first P E N T A D E.

E X P E R I M E N T I.

A VERY tall and well set gentleman, aged about twenty four years, by a fall from his horse, had his skull broken in several places; and being a person of good estate, had several chirurgeons to attend him in the course of his sickness; during which he was divers times trepaned, and had several pieces of his skull taken off, which left great chasms (that I have seen and felt) between the remaining parts. Within about three days after his fall, this knight (for so he now is) was taken with a dead palsy on his right side, which did not equally affect his arm and his leg; the use of the latter being sometimes suddenly restored to him in some measure, and (though seldom) after a while almost as suddenly lost: but his arm and head were constantly paralytical, being wholly deprived of motion; and having so little sense, that it would sometimes lie under his body without his feeling it. But if his hand were pricked with a pin, he could take notice of it. This palsy continued during almost the whole time of the cure, which lasted twenty three or twenty four weeks. And when the chirurgeons were going to close up his head, as having no more to do; one of them, who was an ingenious man, and tenant to this gentleman, opposed all the rest, alledging, that, if they did no more, the gentleman would lead an useless and very melancholy life; and that he was confident, the palsy was some way or other occasioned by the fall, which had left something in the head, that they had not yet discovered. And the knight himself, agreeing to this man's motion, his head was further laid open; and at length, under a piece of proud flesh, they found, with much ado, a splinter, or rather flake, of a bone, that bore hard upon the *dura mater*, and was not pulled out without a great hemorrhage, and such a stretch of the parts, as made the patient think his brain itself was tearing out. But this mischief was soon remedied, and his hurts securely healed up; and he is now a strong healthy man, and finds no inconvenience by having so broad and various a callus instead of the skull, save that he is a little obnoxious to take cold in his head. But the memorable circumstances, for whose sake I mention this narrative, were these: when I asked him how big the bone was, that was last taken out? he told me, that it was less than half the nail of one of his fingers (not his thumb) and that it was almost as thin, being in size and shape like the scale of a fish; but that it did not in his head lie flat, but bore hard upon the *dura mater*. When I asked him, how long after it was taken out, he began to feel some relief, as to his paralytic distemper? he replied, that in less than five hours he found himself, to his great joy, able to move his little finger; and (though this happened in the evening) he was the next morning able to move all his fingers, and within two or three days after to lift up his arm: by which it seemed manifest, that so little a body, as the splinter lately mentioned, produced in so robust a person

son a palsey of the whole side it lay on. For when I particularly asked him, whether, after the taking away of the proud flesh, that encompassed the little bone, he did not find, if he found none before, some relief as to his palsey? he answered, that he found none at all, till the bone had been pulled out, which was not till a good while after the chirurgion had been by degrees eating off the proud flesh, that grew about it. But there was in this case another phænomenon, that I thought little less considerable than the former. For, remembering the important controversy that is agitated among modern physicians and anatomists, about nutrition by the nerves; and having thereupon asked this knight, whether he did not find an atrophy in the limbs of his body, that were affected? he told me, that when he began to be paralytic on that side, it by degrees much wasted, and the paralytic leg was very much extenuated; but the arm and hand much more, seeming nothing but a system of bones, with the skin pasted on them. And when I further asked, if upon the removal of the bony splinter abovementioned, the atrophy of the parts did not also begin to lessen; he answered affirmatively, and told me, that in no very long time his leg and arm recovered their wonted dimensions; and in effect I (some days since) saw the restored arm well plumped up with musculous flesh, though the weather were exceeding cold. And he further told me, that he found no difference between the limbs that had been paralytic, and the others, except that they would grow sooner and more sensibly cold in sharp or frosty weather.

THIS gentleman answered me, (to add that upon the by,) that during the course of his cure, he was very frequently (almost every second day) let blood; that he wanted not appetite to his meat; that for the most part he slept indifferent well; and, which was more remarkable, upon so great a hurt of the head he did not vomit, nor had afterwards any convulsions.

II. AMONG other instances I have met with, that shew the great power, which sudden passions of the mind may have upon the body, I remember, that a woman of middle age, complained sadly to me of the mischief, a fright had done her; for she related to me, that, having taken along with her to a meadow by a river-side, a little boy, that she was dotingly fond of, whilst she was busy about the work she came thither for, the child stole away from her, and went along the bank, to delight himself with the view of the stream; but being heedless, it seems, by circumstances, that he set his foot upon some piece of ground, that the water had made hollow; upon which account, the earth failing under the weight of the boy's body pressing it, that and he fell together into the river: in the mean time, the poor mother casually missing her child, hastily cast her eyes towards the brink of the river, and not being able to see him there, she presently concluded him to be drowned, and was struck with so much horror upon the sudden accident, that tore from her a favourite son, that, among other mischiefs, she fell into a dead palsy of her right arm and hand, which continued with her, in spite of what she had done to remove it, till the time she complained of it to me, who had not opportunity to know what became of her afterwards.

III. ON the other side, to shew, that violent passions, and even frights, may sometimes, though very seldom, do good, as well as harm; I shall here add a relation, that was circumstantially made me by the learned person himself, to whom the accident happened. I familiarly knew a gentleman, that lived to be an eminent virtuoso, and to oblige many by his useful writings, who, when he was a youth, fell into a violent and obstinate sciatica, which continued with him so long, that it left him little hope of recovery; but the devotion of this young man's friends invited them to make him be carried, since he could not go, to church upon sundays; and there it happened, that the town being a frontier garrison, the guards were so negligent, that there was occasion

given to a very hot alarm, that the enemy was got into the town, and was advancing towards the church to massacre all that were in it. This so amazed and terrified the people, that in very great and disorderly haste, they all ran out of the church, and left my relator in his pew upon a seat, that they placed him, and whence he could not remove without help: but he being no less frightened than the rest, as they forgot him, he forgot his disease, and made a shift to hamper off the pew, and follow those that fled: but it quickly appearing, that the alarm had been a false one, his friends began to think in what a condition they had left him, and hastened back to help him out of the pew, which, whilst they were going to do, they, to their great surprise found him in the way upon his feet, and walking as freely as other men. And when he told me this story, he was above forty years elder than when he was thus strangely rescued, and in all that time never had one fit of the sciatica.

A D V E R T I S E M E N T.

It is easy to be observed, that of the two kinds, into which chemists may be conveniently enough sorted, the number is greater of those, that are not professed physicians, than of those that are: and yet several of the former sort are led by their more free curiosity, or their particular designs, to allow a large scope to their trials; and so in their experiments upon various bodies, to operate upon some of those that may be reduced (either directly, or by fit applications) to the *materia medica*, and afford uncommon preparations: which, though designed for other purposes, may, by a skilful physician, with a light variation, and perhaps without any, be made to afford good medicines: and therefore I think it may be no inconsiderable service to the public, if, by the leave and assistance of the authors, divers chemical experiments, that are not directly useful to their immediate purpose, were not (as is usual) thrown away, but put into the hands of some sagacious physician.

Upon these grounds, I thought myself little less than obliged, to set apart now and then an experiment, that contained some uncommon preparation, which seemed applicable to medicine; and to try whether, though, being in the country, or in some other inconvenient circumstances, I had not opportunity to prove it myself, the notice given of it might not happen to be of use to a skilful physician.

I SHALL therefore partly in this chapter, and partly (if God permit) in some following chapters and other writings, tender to such a one some few of the experiments of this sort, that I lately lighted on among my *adversaria*, and that seemed not incapable to be made of some service to the physician's art.

Of the good and bad effects of these I shall be glad to be informed, that they may be either used more freely and improved, or corrected and quite laid aside; and I desire that this short preamble may serve for a general one to all the other designed chemical medicines, that I shall venture to propose hereafter.

A designed chemical medicine.

IV. I KNOW how much men are prejudiced in some whole countries against vomitive medicines; and I remember we have had here in *London* a physician of great fame and practice, that would turn over a patient to another doctor, if the case were such, that the patient would needs make use of emetics. And I readily acknowledge, that they are edged tools, that require a skilful hand, to employ them without danger of doing more harm than good. But since experience shews, that where the patient can bear them, and the disease requires them, they act more speedily and effectually than other evacuating medicines; and since the generality of our physicians, not excepting some,

some, that are justly reputed very cautious, do not scruple frequently to make use of the infusion of crocus metallorum, though it do not seldom prove a remedy harsh enough; I shall venture, in compliance with some ingenious physicians, and others, that have often made use of a medicine, that goes under the name of my emetic drops, to communicate the preparation of them; without pressing the use any other-wise, than by confessing, that divers practitioners of physic, of differing sentiments, agree in assuring me, that they have not yet found any emetic to work so effectually, nor with more ease and safety, than this liquor; which some of them prefer by much to other antimonial vomits; and especially to the infusion of crocus metallorum.

In preparing my vomitive liquor, I have not always employed the same proportion of the ingredients it is made of, nor did I find it necessary to be nice in that matter. But the proportion I somewhat prefer, is to take two parts of well chosen and finely powdered antimony, and on these to pour three parts of the menstruum, *viz.* sp.

; which ought to be rather moderately strong, than too much rectified. These are to be distilled together in a glass retort, fitted with a receiver not very small, till there come over a great part of the menstruum, which will usually, towards the close, be accompanied with red flores (sometimes copious enough) which being separated by filtration through cap-paper, the clear transmitted liquor is to be put into a glass, not newly washed, but dry on the inside, and to be kept close stopt from all intercourse with the air.

THE dose is usually to a man or woman, especially at the first time, from four or five, to seven or eight drops: but I know an ingenious physician, that gives to ten or twelve, or a few more drops, if the case be urgent; and by that means, he told me, that with a small button-bottle, that I chanced to give him a little before, he did, in two or three hours, rescue three gentlemen, that, by a very bad surfeit with very bad circumstances, were suddenly brought into great danger of speedy death, and carried to a neighbouring tavern, as being too ill to be carried home.

THE vehicle may be a spoonful or two of wine, or black cherry-water, or (which divers persons chuse rather) of spring-water, drinking up the liquor immediately after, because there will some precipitation be made; and then taking two or three spoonfuls of the same vehicle to wash it down. It usually begins to work early, and does it without causing near so much straining as vulgar emetics; and yet makes copious evacuations, and sometimes so eradivative of the morbid matter, that the physician lately mentioned, who cured the three gentlemen, having a poor patient, who had conflicted for above three years with an ague in several types, but most commonly quartanary, perfectly cured him with two doses of these drops, and a julap made chiefly of the distilled water of a common vitriolic mineral. And this cure seemed therefore to me, when the physician gave me an account of the drops he had from me, the more considerable, because the patient had made use of great variety of remedies; and particularly he devoured great store of the Jesuits bark, or cortex peruvianus (perhaps because it was not well conditioned, or skilfully administered,) which sometimes altered the type of his ague, turning it to a single or a double tertian, and sometimes kept off the fits for a while, when it was a quartan, but never cured him quite; and left him in a deplorable estate, wherein the emetic drops found him.

THOUGH I sent this medicine to several patients, in whom, thanks be to God, it succeeded more than ordinarily well; yet I durst not venture to give it to children, or to very young persons; but having gratified an ingenious surgeon, of good practice, with a stock of it, the trials he made upon divers persons, with great success on other patients, imboldened him to give it to boys and girls, and afterwards even to several children; whereof he gave me good account, only he discreetly took care to propor-

tion his doses to the age and strength of his patients, and not to give the whole dose at once, but divide it into two or three parts, that if the first should work within half an hour, or less, the second should not be given, or lessened in quantity. And if neither the second did work within about an hour, he added the third. And by this cautious method, he assured me, that he had suddenly relieved several children in bad cases, and found not any mischief or danger ensue upon the administration of it. But children being tender creatures, this is to be further and cautiously tried.

P O S T S C R I P T.

HAVING had occasion to keep by me some vials furnished with the emetic drops, longer than I thought I should need to do so; I observed, that, in tract of time, there began to subside a white powder, wherein a good part of the emetic faculty of the medicine may be supposed to reside: therefore it will be best either to employ the liquor in no long time after it is made, or if one has not leisure or conveniency to do so, to shake the vial well (that the powder may be raised and well dispersed through it) just before it be administered.

A designed chemical medicine.

THERE are many, that having a high esteem for chalybeat waters, such as those of the *Spa* and *Tunbridge*, which yet in many places are not to be had at all, and in few to be had well conditioned, are very solicitous to find succedaneums to them. To gratify some ingenious persons of this sort, (and improve a casual hint taken from a book of a somewhat like preparation propounded for another purpose,) I remember I employed a way of emulating such waters, that answered the outward phænomena of colour and taste, and seem by the paucity and harmlessness of their ingredients like to be innocent medicines. I had no opportunity to make trial of them in physic, but finding, that some inquisitive cultivators of that art valued them more than I did, I committed the experiment to paper, and now suffer it to come abroad, that it may be tried by physicians, and either rejected or made use of as success shall direct. The experiment as I made it was this.

WE took one part of very good filings of z , and ten parts of good distilled vinegar. These we put into a bolt-head, and stopped it well; and then in a mild heat of sand we digested them for about three days, and afterwards augmented the heat till the liquor appeared of a deep orange colour, but yet transparent. Part of this tincture we poured off, and kept well stopped by its self, because though by a longer digestion, and a greater heat, we obtained a very red tincture, yet we did not so much value it, because when the menstruum is over impregnated, the metal usually precipitates, and the fine colour is destroyed. Of the first reserved tincture, we let fall four drops into zviiss. (3ss.) of clear common water, whose colour was not thereby sensibly altered; and the vial containing this mixture being well shaken, that the tincture might diffuse itself the more thoroughly, we kept it carefully stopped for use, as being our fictitious or counterfeit *Spa*. A spoonful or somewhat more of this, with about a quarter of a grain, or less, of good fresh powder of galls, would presently afford a purplish tincture, like that of natural springs impregnated with Mars, such as the water of the *German Spa*, or of *Tunbridge* in *Kent*: if one's mouth were washed with it, it was found to have, like those natural chalybeat waters, a manifestly ferruginous taste. *N. B.* These artificial acidulæ are to be administered in no long time after they are made; for experience has informed me, that (at least sometimes)

times) when I kept them too long, within not many days after they were made, they would lose much, if not most of their briskness and force. And I sometimes perceive, that there would subside to the bottom a certain red or reddish substance, as it were oker, which was a token of the degeneracy of the liquor; and some such thing I have observed in some natural chalybeate waters too long or negligently kept. But our acidulæ may be so soon and so cheaply made freshly, that the above mentioned inconveniency will scarce to the skilful seem considerable.

The second P E N T A D E.

E X P E R I M E N T II.

BECAUSE it may be on some occasions of use to a physician, to have ways of discovering the adulterateness of bezoar stone, which for its dearness is often counterfeited, and not easily discerned to be so by the common ways of exploring, which use to be uncertain enough; it may not be amiss to communicate a new way of trial, which it is unlike that impostors have dreamed of, or, if they should know it, can easily elude. And this I am the rather willing to do, because the proposed way may afford an useful hint to the sagacious enquirers into the nature, and some of the preparations, that may be made of the bezoar stone; which though it be a drug too much magnified by some physicians, especially those that depend on it against the true plague; yet a physician of great experience, and rather a severe than any ways a partial judge of it, allows it to be an excellent remedy even in malignant and ill-conditioned fevers, at least if they be not truly pestilential. One of the ways I employed in treating the bezoar stone may be easily gathered from the ensuing transcript of one of my registered experiments.

WE took forty or fifty grains of choice oriental bezoar stone reduced to powder, and in a bolt-glass poured on it zvi. of good spirit of nitre, as well to try, whether this liquor would prove a fit menstruum for this stone, as we found it to be for the calculus humanus, as for other purposes. And though, this affusion being purposefully made in the cold, the liquor did not seem at first to work on the stone; yet soon after it fell violently upon it, and dissolved the greater part of it, not without noise and a notable effervescence. The solution was almost red, and the glass being put in a digestive furnace, the whole powder was not only dissolved, but, being left a night or two in a north window, it afforded divers saline concretions, much larger than could well have been expected from so small a quantity of matter; and these crystals, whilst they were yet in the glass, might easily be taken for crystals of salt-petre, so great was their resemblance.

To manifest, how much the faculties of loosening and binding are relative things, and depend upon the disposition of the body to be wrought upon, and so upon the congruity betwixt the agent and the patient, I know an ingenious gentlewoman, on whom cinnamon, which generally is a considerable astringent and stomachic medicine, has a quite contrary operation, and that in a strange degree; insomuch that (having found, by two or three accidental trials, that a very little cinnamon seemed to disorder her stomach, and prove laxative) she resolved once to satisfy herself, whether those discomposures came by chance, or no; and having strewed some powdered cinnamon upon a toast, she was going to put into her ale, upon eating the toast she was copiously purged for two days together, and that with such violence, that it put her into convulsion fits, and a kind of spasmus cynicus, which she could never be perfectly freed from being troubled with from time to time for three years, as was the other day averred to me, and divers others that know her, by her husband, who is himself a learned man and a professed physician.

A PROSPEROUS physician, to whom I had recommended some things relating to his profession, whilst he practised it with success in the capital city of *Ireland*, where at that time there raged a new and violent fever, whereof multitudes died, very few patients recovering of it, happily lighted on a method, that proved, through God's blessing, very prosperous. This doctor, returning into *Ireland*, some time before having been desired by me to send me an account of some things relating to natural philosophy and physic, that I named to him, wrote to me, in answer to some of my enquiries, a letter, out of which I thought fit to make this extract, because I know not, but that it may give good hints towards the cure of some other ill-conditioned fevers.

Dublin, Feb. 27, 1682.

I HAVE employed *ens veneris* for the removal of a *subtus tendinum*, in a person dangerously sick of a *febris petechialis*, (a disease fatal to very many here for these twelve or fourteen months); and found, that it answered my hopes in three or four hours after I gave it in conserve of borragé flowers.

I HAVE, since I came from *England*, thought of a method of curing the aforesaid fever, which has not once failed me, though I made use of it for sixteen or eighteen several persons, many of which would certainly die, if treated after the usual manner in this case. If I should tell you, from what observations and reasonings I came to alter the method of cure, I should be very tedious. I shall therefore at present wave that, and proceed to tell you, that when first I come to any sick of this disease, if I find costive, (as generally they are) I prescribe a glister, and after that an epispastic plaister, six or seven inches broad, and eight or nine inches long, to be applied between the shoulders: the blister being well raised I order to be dressed carefully, stripping off the cuticula. This continues running till the fever is gone off, which is most commonly in ten or twelve days, if they have not kept up too long with it, and then we cannot certainly foretel the time of the fever's declination: for the whole time till the going off of the fever, I prescribe emulsions of *aq. aronis, card. bened. citrij totius & syr. granatorum cum aceto*. I allow of orange and butter-milk poffets, of roasted apples, flummery, or any other light and cooling thing they call for.

By this method I keep the *genus nervosum* and brain from being affected, and consequently secure my patients; for as many as I have ever known of them die, that were troubled with this disease, died of a disorder of those parts. I do not defer the blistering plaisters, as others do, till I find my patients delirious, lethargic, convulsive, or otherwise affected in their heads and nerves, finding by the experience of others, that then they most commonly prove ineffectual, because of some morbid matter's being too deeply lodged in these parts. I do not prescribe, except upon some extraordinary occasions, any volatile salts or spirits, or any thing too apt to quicken the already over-brisk circulation of the blood, having experimentally learned, that by these often used the brain and nerves become sooner than ordinary affected, forasmuch as they deeply insinuate themselves, and drive with them some morbid matter into the brain and nerves. I find bleeding bad, being generally fatal. If I doubt of the recovery of any of my patients sick of this disease, it is only when I find, that they have been let blood, or lain for eight or nine days before I came to them; though I have brought through it even persons in those circumstances.

A designed chemical medicine.

I SHALL not, because I need not, discourse of the medicinal virtues of steel, in a city, where many learned physicians do so much esteem and employ chalybeat medicines

cines as they do in *London*; and therefore I shall content myself at this time to offer you a couple of preparations of steel, that possibly you have not met with or thought of.

I. CONSIDERING, that most of the ways made use of by chemists to prepare steel tend, by dividing it into very minute parts, to make it more liable to be wrought on by the liquors of the stomach, and some other parts of the body; and that the generality of these chalybeat preparations are wont to be made only with acids, whether manifest, as oil of vitriol, spirit of vinegar, &c. or occult, as brimstone, which though insipid in its natural state, when it comes to be melted discloses its hidden salt, and works on σ by a sharp acidity: considering this, I say, and that men have confined themselves to acids in working on steel, because they supposed instruments of that kind were necessary to dissolve that metal, I thought it might do you, and some ingenious men of your profession, some little service, if I proposed to you a way of opening the body of steel, that, though I gave a hint of it divers years ago, is, for ought I know, yet unpractised.

We took then several ounces of highly rectified spirit of fermented (or putrified) urine *per se*, and consequently without quick-lime, and poured it upon as much filings of steel freshly made, to be sure not to have any rusty ones, as we guest would at least suffice to satiate it fully. These we put in a moderately warm place, where the menstruum wrought on the metal for divers hours together, and dissolved a considerable part of it. This solution we set to filter, and found it of a taste considerably strong, but very different from any of the chalybeat preparations, we remembered, that were seen made with acids. The liquor, being kept in a stopp'd vial for some days near a window, did in the cold let fall by degrees a considerable quantity of powder of a deep green colour, which surprized some virtuosi, to whom I shewed it, especially because the liquor itself was not of that colour; though at least the superficial part of what remained (in plenty) in the filter did also in the air acquire a green colour. But though our solution, poured off from the subsided powder, was warily and slowly evaporated, yet we did not find it would well crystallize. What use may be made in physic of preparations of this kind, I leave to you, whose profession, as well as curiosity, will engage you to consider. I do not presume to tell you, but in general it seems, that steel prepared with volatile spirits of the animal kingdom, that are wont to be friendly to nature, and are very contrary to acids, may have new qualities very differing from those of steel prepared with acids, and may be more safe in some cases and to some patients. With what other volatile menstrua I have dissolved Mars, and what phænomena some trials I made with that metal opened by such salts, you may command an account of, if you thing it worth desiring.

A. designed chemical medicine.

ANOTHER experiment, that I made on steel, was designed to make as much of it volatile, as I could with a menstruum, not so corrosive or dangerous to the body as oil of vitriol, or spirit of nitre, which, especially the former, are employed by divers chemists to make chalybeat preparations, that yet are not volatile. The medicinal scope I had in my eye (for I had also a chemical one, that belongs not to this place) was to try, if I could by it obtain any sulphur of Mars, which the commendations, that some, even of those chemists, whether adepts or not, whose authority I most regard, represent as an excellent medicine, especially in cases that require anodynes, and which the others or the same speak of as a graduatory substance (as to some metals) or both. If you should ask me, why I did not make use of the common vitriolum martis, which is easy to be had in the shops of chemists? I answer, that
my:

my design being to try whether or no I could obtain a sulphur, that might properly enough (though not in the utmost rigour) be called sulphur of Mars, that which is made the common way would not answer my end, since though I should be able from this vitriol to obtain a real sulphur; yet I should not think it safe thence to conclude, that it came from the metal, and not from the menstruum; because I have several times, from oil of vitriol itself obtained no contemptible proportion of yellow and combustible sulphur. To which I add, that the acquisition of a metalline sulphur, though it was not the only thing that I aimed at in this preparation, for I presumed, that at least I should make a very great comminution of the parts of steel, which is one of the main things aimed at by the more rational physicians in the preparations of that metal.

UPON these and the like grounds, I pitched upon good spirit of sea-salt, as a menstruum, much fitter for my purpose than either oil of vitriol, or the acid part of sulphur; and accordingly, in a good many ounces of this menstruum, we dissolved as much as we easily could of choice filings of fine steel; and, having filtered the green solution, we very slowly evaporated it in a glass vessel, and took such care not to spoil the matter, that we had store of fine green crystals, that were not very small, and looked prettily: most of these we put into a strong (but small) retort, and by degrees of fire, and a strong one, for the last hours, we obtained divers ounces of a liquor, that came over in white fumes, like mists driven by the wind, and afforded a sulphureous smell: this liquor we rectified, and had a yellow ponderous spirit, that seemed to be much more of kin to the spirit of sea-salt, than to the common oil of vitriol; especially since, being mixed with aqua-fortis, it would, like spirit of salt, make it a menstruum, that would even in the cold dissolve gold in thin leaves. Which last words I add, because, having put into a little of it already made yellow, by having dissolved leaf-gold a very thin plate, but a pretty deal thicker than a leaf of hammered gold, the menstruum made it look all over white, almost like silver, which seemed to argue, that this vitriolate menstruum differed from common spirit of salt. And however, it may be worth taking notice of by the by, that not only vitriols blue, as is well known to chemists, but that vitriols of one of those colours, and whereof the same metal is the basest, may differ much from one another on the score of the various (and to us, perhaps, unknown) menstruum, that dissolves the metal, since our green vitriol yields liquors very different from common English vitriol of Mars made with oil of vitriol, though all the three be green. Which may give us some reason of the uncertainty, whereof vitriol is mainly employed; and it is perhaps worth remarking, that though we did not find the vitriol of Mars made the common way, nor even Roman vitriol to dissolve in a vinous spirit totally inflammable; yet it would easily enough dissolve our saline vitriol (if I may so call it), which solution (to hint that in *transitu*) you may perhaps see cause to employ as a medicine in several cases, and particularly as a styptic in wounds, since its taste is very astringent, its parts very subtil, and made fit by the vinous spirits to prevent corruption; especially in those climates, where chirurgeons complain, that they can scarce prevent the breeding of worms in wounds, unless they do betimes dress them with spirit of wine or brandy.

BUT that which we chiefly aimed at in this operation was the dry part, of what was elevated by the force of the fire. This we found to be distinguishable, partly by its situation, and partly by more durable accidents, into three kinds of substance; whereof one was almost like a powder, which, after the contact of air, did in a while come over to be of a yellow colour, almost like sulphur, but it was not indeed truly combustible sulphur. The other substance consisted of larger parts, and was of a deep colour, between

red and brown. But the third, which seemed the most copious of all, was made up of fine parts, larger than the former, of a deep reddish colour, and adorned with a fine gloss, like that of scales of fishes, that looked very prettily.

THE caput mortuum was found to be of a texture, that would have surprized most men; for a great part of it appeared to be turned into a talky substance, consisting of pretty broad and very thin plates, smooth and glossy, that lay upon and against one another, like those that make up Muscovia-glass, when the pieces are more thick than large.

C H A P. V.

Containing Experiments and Observations solitary; in two Pentades.

The first P E N T A D E.

E X P E R I M E N T I.

A notable comminution of gold into powder, that will sink in water.

TO manifest into how great a multitude of corpuscles, gross and heavy enough to sink to the bottom even of a saline liquor in the form of precipitate or powder, I thought of this expedient. We took a grain of refined gold, and having dissolved it without heat in a competent quantity of good aqua regia, we put to it by guess about two spoonfuls of water; and then by a thread we hung in the mixture a little bit of clean metalline body, and kept it suspended in the liquor for many hours (or some few days.) By this means we obtained, as we expected, a precipitate of a fine and deep colour, so copious and so light, that it was a long time before it would all settle at the bottom. Then looking upon the remaining part of the suspended metalline body, we found it so very little less than when the whole was first put in, that the diminution of it was not judged to amount to near a grain. By which experiment it appeared, that one grain of gold, not swimming in parts separately invisible, as it is in solutions, but reduced to a manifest powder, seemed to make a considerable quantity of precipitate at the bottom of the cylindrical vial, whose diameter was about an inch, that we kept it in. And this glass being a little shaken, the precipitate would rise like a mud, and be so thoroughly dispersed in the form of a powder through the whole body of the liquor, and a greater quantity of water added to it, that at first it would seem opacous, and after some time it would appear like a high and lovely purple solution. So that one grain of gold (for the colour argued, that there was some of that metal, in every corpuscle of the precipitate) was reduced into as many grains of powder, as sufficed to lodge themselves in all the particles of space great enough to be visible, that were contained in a mass of sixteen drachms (i. e. two ounces) of water.

E X P E R I M E N T II.

A proof of the metalline nature of granates.

I HAVE elsewhere endeavoured to shew, that divers, if not most, of the real virtues of some gems (for there are too many fabulous ones ascribed to them) may in probability proceed from the particles of mineral juices, that were admitted whilst the matter was yet in *solutis principiis*, or at least soft, and afterwards coagulated with the lapidescent part of the stone. In confirmation of this conjecture, I shall now observe,

that having, upon some grounds not necessary to be here mentioned, suspected, that granates contain (some of them) besides some other metalline substances, divers corpuscles of a martial nature; I made choice of some small ones, which by their deep and almost dark colour (to name no other signs) I guessed to contain somewhat of iron or steel; and applied to them a pretty vigorous loadstone, which, as I expected, readily took them up, and to which they constantly stuck afterward, till I forcibly separated them from it. But though I tried this upon more parcels of granates than one or two, yet I found, that there was not many in one heap, that would easily adhere to the magnet.

EXPERIMENT III.

A GENTLEMAN eminent for his travels into eastern parts, and for his skill in jewels, told me, in confirmation of my opinion about the origin of gems from fluid materials, that he had seen a white sapphir, that was a tablestone, as they speak, *i. e.* flat and not cut in facets, about the middle of which there was a cavity about the bigness of a large pin's-head, or small fitch, that contained in it a drop of liquor, that it seems could not be coagulated into stone with the rest of the matter: which liquor, he said, was very easily discernible by its shifting places in the cavity, when the stone was put into differing postures. And when I asked, whether there was no flaw or commissure in the stone, at which the liquor may be suspected to have got in; he assured me, that there was none, but that the cavity was every way encompassed by the solid stone, and was about the thickness of three barley corns beneath the upper superficies of it.

SCHOLIUM.

It may be here fit to give notice once for all, about the experiments, that are in the following collections stiled solitary, that though most of them are delivered nakedly as matters of fact, without any such introduction or subsequent reflection, as may be met with sometimes expressly, and oftener by intimation in divers others; yet that it should not be thence inferred, either those, that are simply recited, were lighted on by chance, or made at all adventures; or that they are of no use, because for the most part there is not any expressly ascribed to them. For as they were not written without a particular occasion and scope too, so that many of them may be applied to good purposes, will, perchance, be found here and there in our other writings. And to make it probable in general, that most of them may not be useless, it may perhaps suffice, that we refer to what we have elsewhere purposely discoursed about the uses of experiments (even) to speculative philosophy.

THIS may pass for a general scholium applicable to most of those experiments, that are not attended with any particular scholium, nor any thing in the experiment or observation itself, that may easily, by an attentive reader, be made to supply the place of a scholium. Which last clause I add to intimate, that besides my haste, another reason, why so many scholia, as may be expected in the following collection, will not be found in it, was, because the proœmial part did, on several occasions, make it needless to subjoin annotations.

EXPERIMENT IV.

AN ingenious and credible person (Mr. *W.*) assured me, that in one of the fine gardens near *Genoa*, that he delighted to visit, there was a pond, which being made on the side of a hill, the wall next the bottom of the hill was so high, that men could

not look over it into the pond, nor be at all seen over it by the fishes in the pond; and yet he has several times observed these fishes to be called together by the gardiner as he pleased, with a certain noise, that the gardiner made to assemble them, though neither he nor any man else could be discovered by the fishes, that readily obeyed their summons.

This relation may be of use in the controversy, whether fishes hear under water.

EXPERIMENT V.

UPON occasion of what is elsewhere said of the production of vivid apparent colours by the breaking of the beams of light, on corpuscles extraordinary minute, though solid; I took a globe of rock crystal, which being for a certain use sawn in two by a cutter of gems, and having looked upon the flat surfaces, obverted to the sun beams, the little particles, that (notwithstanding their seeming smoothness in the shade) asperated their surfaces, did so refract and reflect the light, as to make them exceed the vivid colours of the rain-bow, (but in a somewhat interrupted manner) sometimes on one part of the surface, sometimes on another, as the surface happened to be situated in reference to the sun.

AND having caused a choice and fine grained touchstone to be likewise sawn asunder by the same artificer to make two of it, I observed upon the new surfaces made by this action, that to the touch felt smooth and polished, such vivid colours, as I lately mentioned to be when these surfaces were put into various positions in reference to the sun and eye; so that notwithstanding the great transparency of the crystal, and great opacity of the touchstone, their superficial corpuscles were found fit to exhibit (in due positions) the vivid colours we admire in the rain-bow.

The second PENTADE.

EXPERIMENT I.

HAVING for less than two hours borrowed an *oculus mundi*, whose colour was white, ^{10 Cent.} whose figure was round and plain convex, and whose diameter I judged to be about a third part of an inch (rather less than more) I put it into a very shallow glass vessel almost filled with fair water, and observed within one minute, or thereabout, with the minute-watch, that one part of the edge began to appear somewhat diaphanous, and the whole stone did by degrees lose its whiteness, appearing of a dark brownish colour: when this change had reached the whole surface, I looked upon my watch, and found, that the stone had lain nine minutes in the water; out of which having taken it, I perceived the body was grown semi-diaphanous, and the parts near the edge being less thick, appeared to have lost much more of their former opacity, than the innermost part had. Then putting the stone presently into the water again, I let it lie there so long till the time effluxed, since the beginning of the experiment, amounted just to half an hour. Then taking it out, and wiping it, I found it was grown much more clear, since being held against the light, it looked almost like yellow amber, but not quite so diaphanous. Then I exposed it to the contact of the air, in the scales of a very good balance, (where it weighed four grains and about a quarter) and left it for a quarter, or near half an hour in that balance, to try if by the recess of any imbibed aqueous moisture it would become lighter; but want of time hindered me from completing the experiment, but did not deter me from making another observation, which was, that within about a single minute of an hour, a portion of the stone, near one part of the edge, was manifestly grown opacous and whitish, and within not many

minutes after the whole stone began to appear in a changing condition, but did not change in every part at once, nor did the alteration make an uniform progression; but here one might successively discover divers white arches, or as it were zones, that were parallel enough to one another; and being quite opacous, intercepted between them other little zones, which being yet semi-opacous, appeared of a brown colour, and concurred to make the stone look like a very pretty agate, wherein the whiteness made a continued progress as long as the time permitted me to observe it: and the possessor assured me, that within an hour or two it would be all of a cream white (as he expressed himself) which I thought the more credible, because I saw one part of it that was pretty broad, to have obtained already a whiteness, little, if at all inferior to that of ivory.

EXPERIMENT II.

Remarkable observations about hurricanes.

THE late governor of the *Bermudas* islands, (very much subject to hurricanes) in answer to my questions about the presages of those hideous tempests, informed me, that these were of the principal forerunners. First, that the sea would manifestly swell at some distance from the shores, insomuch that the fishermen would divers times make to land, and warn the inhabitants, upon confidence of that presage, to provide against that dismal storm, though the sea were then smooth enough. Secondly, that the sea would beat with great noise against the shore, especially the rocks, though there appeared no manifest cause, as upon the account of the wind or tide, why it should do so. And this sign would sometimes not appear till many hours, or perhaps a full day after that forementioned. And sometimes it was observed, that the sea would now and then suddenly invade the shore, and gain further upon it than could be accounted for by the wind or tide, and then quickly ebb away beyond the usual low water-mark, and after return again with more fury, and fall back further than before. Thirdly, that sometimes there would be perceived an ungrateful smell in the air, before the hurricane began to blow. And fourthly and lastly my relator affirmed to me, both he and others had seen many bundles, as it were of long streaks of differing colours, some whitish, some reddish, and some bluish, or greenish, which by reason of their figure are usually called in those parts horse-tails: and these were seen in parts of the sky, where the air was troubled indeed, but yet no formed clouds did appear to the eye.

EXPERIMENT III.

A monstrous pearl.

YESTERDAY a curious person came to shew me a monstrous pearl, if I may so call it, because it was very irregularly shaped, and of an enormous bigness. For though it were so artificially set in gold, that by the help of a little of that metal fitly placed here and there, the whole jewel represented a lion; yet I made shift to measure it exactly enough with a pair of calāpar compasses, (as they call those, whose legs are made archwise) and found the length to be just an inch and an half, and the greatest breadth (where yet it was of a proportionate thickness) to be $\frac{3}{4}$ or $\frac{4}{5}$ of an inch. The colour was orient enough, all but one dark spot, which by its size, figure, and situation, I guessed to be the remains of that part (whether like an umbilical cord or no) whereby it was fastened to the naker or shell of the fish that produced it.

EXPERIMENT IV.

An odd observation about the influence of the moon.

I KNOW an intelligent person, that having, by a very dangerous fall, so broken his head, that divers large pieces of his skull were taken out, as I could easily perceive by the wide scars, that still remain; answered me, that for divers months, that he lay under the chirurgeons hands, he constantly observed, that about full moon, there would be extraordinary prickings and shootings in the wounded parts of his head, as if the meninges were stretched or pressed against the rugged parts of the broken skull; and this with so much pain, as would for two or three nights hinder his sleep, of which at all other times of the moon he used to enjoy a competency. And this gentleman added, that the chirurgeons, (for he had three or four at once) observed from month to month, as well as he, the operation of the full moon upon his head, informing him, that they then manifestly perceived an expansion or intumescence of his brain, which appeared not at all at the new moon, (for that I particularly asked) nor was he then obnoxious to the forementioned pricking pains.

EXPERIMENT V.

An uncommon experiment about heat and cold.

To confirm what we have elsewhere delivered about the mechanical origin of heat and cold, we devised the following experiment: we took a small and hermetically sealed thermoscope, whose stem was divided into parts, equal enough as to sense, by little specks of amel, that sharp liquors might not eat off or spoil the marks. The ball of this instrument we put into a slender cylindrical vessel, (called in the shops a mustard glass) and more than covered it with strong oil of Θ , and left it there a while to be reduced to the temper of the surrounding liquor. Then we cast upon it by degrees, grossly powdered, * which presently was wrought on furiously by the menstruum; and by this conflict, was produced a seeming effervescence, with great noise and store of froth, which more than once was ready to run out of the vessel. But for all this seeming ebullition, the mixture instead of growing hot, did really grow colder and colder, as appeared not only when the vessel was touched by the fingers on the outside, but by a surer mark, which was the descent of the coloured spirit of wine. How much further it would have descended, (for the liquor was not near satiated with the Θ) we were hindered from discovering, by an unlucky accident, that broke the thermometer, and put an end to that first part of our experiment. But this was no hindrance to the second part, which for its novelty we mainly designed. For when we poured this actually and considerably cold mixture into three or four times its weight (by guess) of as much common water, that was likewise actually cold; this second mixture did, as I expected, immediately grow so hot, that I did not like to keep my finger for a minute or two upon the outside of the glass.

Novem.
9. 89.

C H A P. VI.

*Containing two Pentades of Chemical Experiments:**An Advertisement about the nature and scope of the chemical experiments contained in the following pentades.*

BEFORE you enter upon the perusal of the following pentades, I think myself obliged to give you notice, that you will be deceived, if you expect to find them consist, either solely or mainly, of spagirical secrets, or difficult and elaborate processes.

processes. I do not indeed deny, that I am not altogether unfurnished with such, as in probability most readers would refer to experiments of that nature; and you may find divers of them scattered upon fit occasions in several of my writings: but in the present tract, though I have not forbore to mention here and there as many particulars of that sort, as I thought necessary to excite and maintain the curiosity, and sustain the attention of a reader, that relishes nothing, that is not seasoned with somewhat that is not common; yet in this treatise, wherein I aimed not to appear a chemist, so much as to make my reader a naturalist, it was more suitable to my design, though not more conducive to my credit, that the following pentades (which, God permitting, may, in tract of time, much encrease in number) should mainly consist of experiments, rather useful than specious; my design being to contribute some sound materials towards the erection of a solid and useful natural philosophy. In making choice of which materials, I usually prefer those experiments, that afford the more light, to those that appear with the most lustre; and those that are proper to encrease the reader's skill, to those that make an ostentation of the writer's. On which ground it is, that whatever I may do, where I purposely recommend chemistry, I make this small collection consist mainly of simple and not intricate, or elaborate experiments; those that are simple being not only more easy to be tried, and if need be, reiterated without much trouble, or danger of erring; but (which I more regard) more easy to be judged of as to their causes, phænomena and effects, and consequently more fit to ground notions and reasonings upon: divers of which may probably in the applications, that sagacious persons may make of them, prove to be of practical as well as theoretical use. Thus though a wedge of gold and a diamond be, one more rich and finely coloured, and the other more precious and sparkling, than a piece of steel and a flint; yet on many occasions the two latter are far more serviceable to mankind than the former: since not those, that are more prized for themselves, but those, that in comparison seem despicable, afford sparks, which do not only give light, but are fit to kindle fires, which both afford incomparably more light, and in the application are of excellent and necessary use in the kitchens of families, the forges of smiths of all sorts, the furnaces of mine-men, and the laboratories of chemists.

The first P E N T A D E.

E X P E R I M E N T I.

To dissolve crude gold with dry bodies.

BECAUSE the generality of chemists make so great a matter of *aurum potabile*, though they cannot deny, but that by their preparations it is not made irreducible; and because also I am willing to grant, that even some preparations, that leave the metal reducible, may yet be of considerable use in physic, (the grounds of which opinion I elsewhere declare, and shall not here repeat) I will in this place set down a process, which though I do not overmuch value, served me well enough on some occasions, to vie with those, that much vaunted their particular ways (as they thought them) of making *aurum potabile*. I then told them, I could make one in an hour or two's time without a furnace, and that without any other distilled liquor whatsoever than common spirit of wine well dephlegmed.

THIS I did several times after the following manner. I prepared a saline mixture, consisting of one part of sal armoniac, two parts of roch alum, and four parts of pure nitre. This being well pulverised and mingled, I rubbed diligently in a glass or marble mortar, with 15 or 16 parts in weight of the whole mixture of leaves of gold, such

such as apothecaries and book-binders use. Then I put this into a small new crucible, and putting a few, and but a few kindled coals round about it, and at a little distance from it to neal the vessel; I soon after approached them, till the heat made the matter melt, and so with that gentle fire I kept it in fusion, till it visibly emitted no more fumes, but grew dry again.

THIS sign appearing, I presently took it off from the fire, and while it was yet warm, dug it out, as clean as I could; and having seasonably pulverised it, that it might not attract the moisture of the air, I put upon it some highly rectified spirit of wine, which within an hour or less time was enobled with a rich golden colour. And accordingly I found it to be a real solution of gold, by divers trials, that I purposely made to evince it to be so.

OF this and some other less common preparations of ☉ more may be met with hereafter.

EXPERIMENT II.

Luna cornea by distillation.

THERE was taken ℥iii. of well refined silver, thinly laminated, and six of common sublimate. This was put first into a retort, and the silver cut into small pieces was put in after, that the matter lying uppermost might be penetrated by the ascending fumes: but the fire having not been made strong enough, the sublimate was elevated to the uppermost part of the retort, and left the silver scarce at all changed in the bottom of the glass. Wherefore we put the same sublimate and metal into another retort, and administering a stronger fire, that the sublimate might be thoroughly melted before it could flee away, we obtained no running mercury at all, but the greatest part of the sublimate was elevated in its usual form, leaving behind it the silver in a lump, which stuck hard to the bottom of the glass, and appeared much altered. For besides, that there was acquired ℥i. in weight, many of the pieces of metal stuck together, and seemed at least half melted, and were of a kind of horny and semidiaphanous substance, which would readily enough melt almost like sealing-wax, when I held it to the flame of a candle, at which yet I could not perceive it manifestly to take fire.

SCHOLIUM.

IT is here to be noted once for all, that in this and divers other chemical experiments, there is sometimes much more delivered, than is necessary to make good the title, or the thing mainly intended. But it was thought fit, not to dismember or mutilate the entire memoir as it was registered, because that of the other particulars some may be, though indirectly, referred to the principal part; and others may be looked on as phænomena, which may be of use at least to me, by keeping me from forgetting them, and probably tend to the main design of all these experiments, *viz.* to contribute to a natural history, which may respect practice, as well as theory.

EXPERIMENT III.

Mercury grown warm with silver.

WE took ℥ii. of animated (or antimonial) quicksilver, and put it into the palm of one's hand: we put to it by degrees a drachm and an half of powder of fine silver, made by precipitation with copper the ordinary way (but with more than ordinary care.) Whilst this mixture was making with one's finger, he, that held it in his hand,

hand, confessed he found it grow sensibly warm; and I, whose finger was considerably warm; could not with it perceive any coldness in the amalgame. This in a very short time became of a soft, and (as to sense) uniform consistence, and so soft, that it was like almost melted butter, insomuch that we added half a drachm more of the calx of silver, without rendering the amalgame at all too stiff; and perhaps we might have added the other half drachm, without overcharging that penetrant mercury; in which case it had swallowed up full its own weight of silver, so different it was from common mercury; and when we left off, it had reduced into a very yielding form three quarters of its own weight of solid metal. This ^{aaa} we put into a small vial, and stopped the glass with a cork, to observe, whether the amalgame would harden without intercourse with the free air. Next morning it appeared to be concreted in the glass; and the next morning after that, we broke the glass to take out the matter, which we found considerably hard, but brittle enough.

EXPERIMENT IV.

The durableness of the faculty of a certain prepared mercury to grow hot with gold.

To convince those, that treat the incalcescence of prepared mercury and of gold, as a chemical chimera; I sent, in a concealed way, to the Royal Society some mercury laboriously prepared in my furnaces, whereof $\frac{3}{4}$ being put upon a due proportion of a calx of gold made by the common way, (quartation) they grew presently, and very sensibly hot in the palm of one's hand. I shall now add, that to try, whether this surprising faculty of growing hot immediately upon gold, will continue any long time in the mercury; I lately took some, that I had (for a certain purpose) kept hermetically sealed in a glass egg for divers years, (if I mistake not, ten or twelve at least) and having reiterated the forementioned trial with it, first alone, and then in the presence of a cultivator of chemistry; it presently grew hot with the $\odot$ in the palm of the hand. And having distilled off the mercury, and tried it again, as well as some that was undistilled, if I much misremember not, it did again heat with gold.

EXPERIMENT V.

An uncommon way of operating upon δ .

WHEN chemists expose antimony, for instance, and divers other consistent, but not fixed bodies, to the action of the fire, they are wont to do it in vessels, either open, as when they make calx, or glass of antimony; or at least in vessels, that are not so close, but that there is air included with the matter, as when they sublime it in glasses, or in earthen subliming pots: and though they regard not this included air, because usually there is not much of it in the vessel, yet it may have a not inconsiderable influence on the effects of the fire's operation, not only as it contributes to the ascension and sustentation of dissipated parts of the mineral, but as it affords these corpuscles room to fly to and fro in it, and thereby make associations, or coalitions, and concretions, that otherwise would not be produced. Upon this account I guessed, that it may be, on divers occasions, a thing of use for discoveries, and perhaps too for practice, to employ a method, that the body exposed to the action of the fire may be kept from the contact of the air, at least as to any sensible portions of it, and being as it were included in bodies almost equivalent to solids; and one may suppress the free emission and ascent of exhalations, and so to make an operation, not only in clauso, but as it were in solido, and reduce the parts of the body exposed and perhaps the igneous

igneous corpuscles, to act reciprocally upon one another, without any notable dissipation, or avolation of parts.

To apply now what hath been said to antimony, I shall briefly set down an uncommon way, that came into my mind of operating upon it. We took well powdered $\bar{t}$, and well dried (white) chalk reduced likewise to powder: with these in a large earthen pot or crucible, we made SSS. having a care to make the lowermost and uppermost bed of chalk, and the last thicker than any of the rest, as also that none of the antimonial layers were but of a moderate thickness, that the heat might penetrate them the better: then the vessel being covered, was put among the kindled coals of a good digestive furnace, (not because such a one was necessary, but because it was at hand) where it was kept for a competent time; which according to the bigness of the pot, and the strength of the fire, may be sometimes twenty or twenty four hours, sometimes a day and a half, and sometimes two days or better.

The second P E N T A D E.

E X P E R I M E N T I.

A very uncommon way of making a calx of gold.

It is known, that most chemists, and many physicians, have a superlative esteem for the medicinal virtues of gold, and the preparations of it. And upon this ground, divers of them have long been, and still are solicitous to make calces of gold by differing ways, most of them laborious, and some of them scarce to be safely wrought and used in physic. Wherefore I shall I presume, be easily pardoned, if I here set down a way, that came into my mind, and that I have sometimes used to make a preparation, wherein gold is reduced to very minute parts, without the help of mercury, or of any precipitation made by sharp salts, whether acid or lixivial.

WE took then refined gold, and dissolved it in clean and spirituous aqua regia; and instead of precipitating the clear solution with oil of tartar *per deliquium*, as is usually done, or with spirit of sal armoniac, or other volatile urinous spirits, we first with a very modest heat drew off the superfluous liquor; whereby the gold, with the remaining part of the menstruum, was left in the appearance of a thick and oleous liquor. This done, we poured upon it a treble weight of vinous spirit totally inflammable, and in a short time we had, as we expected, a very subtil powder, or high coloured calx of gold, that subsided at the bottom; the menstruum being strangely dulcified as to taste, and become fragrant in point of smell. When a very few days were past, we decanted the liquor, and put on it fresh ardent spirit, and leaving them a while together, there subsided the like well coloured calx more plentifully than the first time.

I KNOW not, (to add that upon the by,) whether it may or may not be worth while to try to discover, whether this dulcified A. R. spirituousa being drawn off from the subsiding gold, may have acquired any virtue from the opened metal; some trials seeming to argue, that the openness of this calx made it fit to be easily wrought upon by a menstruum, that would not touch water-gold, as they call the common calx made by quartation, nor yet leaf-gold, such as the apothecaries employ; but however the menstruum has acquired such qualities, as make it seem likely to prove an useful medicine, which yet I refer to trial.

By the way we pitched upon to make this powder of gold, it seemed probable, that it would not (at least) be less subtil, and yet would be more mild than common preparations; and nevertheless we thought it might, perhaps, make it yet more secure, if we should, as we did, put upon it a totally ardent vinous spirit, and burn it off once, twice, or thrice, to carry off with it any little corrosive or saline particles, that may have still adhered to the metalline ones.

N. B. THE spirituous aqua regia, mentioned in the process, is so called by me, partly to distinguish it from the common aqua regia, and partly because it is indeed of a more spirituous nature than the common, being composed without any gross salt, such as *, but only of spirits. This menstruum I made for some particular uses: and though it works more slowly than the common chrysulca, yet I often prefer it to this, as that which I can employ to some uncommon purposes; and as it may probably be a more innocent menstruum in making preparations of Sol, designed for medicinal uses. I make it very easily, by mixing one part of good spirit of salt with two parts of strong spirit of nitre, or (when it is not to be used for medicines) of common, but clean aqua fortis.

S C H O L I U M.

THE above recited trial was made as it is delivered; but some circumstances, that I took notice of, and particularly some grains of powder, that, though mingled with the rest, were shining, as if they had been extremely minute, and bright filings of gold; these circumstances, I say, made me suspect, that the success might much depend upon particular and nice circumstances, that may need more exact trial, than I had then occasion to make; and therefore it may be fit, that the experiment be heedfully repeated. It may also be tried, whether the employing common A. R. instead of spirituous, will much vary the experiment.

E X P E R I M E N T. II.

To try how much volatile salt an assigned quantity of water would dissolve, we took ℥iii. of distilled water, and put into it by degrees some dry salt of sal armoniac, (that was very white, and compact enough) keeping the liquor in digestion for a pretty while, that it might have time to dissolve as much as it could. When we found it would dissolve no more in a moderate heat, we took it off, and found, that after standing some hours in the cold, there fell to the lower part of the glass, and settled there a pretty quantity of salt, which we guessed to be about ʒii. which being deducted from ℥iii. that had been in all put in, there remained ʒi. and ʒvi. in the liquor, which by this account had dissolved at least half its weight of salt.

S C H O L I U M.

I DESIRE it may not be thought strange, if, among our chemical experiments, some few shall be here and there met with, that are much less elaborate or promising than others, that I could easily have inserted in their rooms; for I did it on set purpose, partly because oftentimes (as was intimated at the beginning of the chapter) some more simple or seemingly less valuable experiments, may be fitter materials, than more curious ones, for the natural history we would promote; and partly to give an example, if mine can signify any thing, of not disdaining to register some things, that seem mean, if by the light they afford, or the uses they may be applied to, they compensate the want of lustre, and of immediate utility. And the substance of this scholium I desire may be mentally transferred, as occasion shall require, to those following chapters, that treat of chemical experiments.

E X P E R I M E N T. III.

PERHAPS some chemists will think, that the following memoir may give hints, that may be of use on several occasions, both for other purposes, and for theirs, that would draw tinctures from several bodies, that will not afford them in simple spirit of wine, though well rectified.

THE simple spirit of good French verdegreas, being once or twice abstracted from

as much salt of tartar as it would dissolve in the cold, left the salt easily fusible, and dissoluble in highly rectified spirit of wine.

E X P E R I M E N T I V.

I HAVE not been unacquainted with some curious and elaborate preparations of that noble flower the rose; and experience hath convinced me, that it is possible, whatever most chemists think of it, to obtain from roses a true essential oil, that mixes not with water, and is exceeding fragrant: but there are several, that are so far from believing, that an essential oil may be obtained from roses, without being in the form of a butter, but in a liquid one like oil of cloves, or wormwood, that they doubt, whether a true spiritus ardens can be obtained from them, without addition of wine, or some such inflammable liquor. I shall here transcribe the following note, as containing a more simple and easy preparation (than any of those before mentioned) of the ardent spirit of those flowers, and therefore more suitable to the design of the whole chapter.

To make an inflammable spirit of roses.

Two bushels of damask roses (together with a good number of red rose-buds) being beaten, and put into a vessel with water, amounting to about four gallons, were mingled with about a quart of ale-yeast, and kept in fermentation for about five or six days (the weather being cold for the season) and then being distilled *per vesicam*, afforded us a spiritus ardens.

E X P E R I M E N T V.

An experiment about the chemical analysis of pearls.

WE took $\text{z}ii.$ of seed pearl, that were carefully bought for oriental, and without breaking them, put them into a retort, and distilled them in a sand-furnace by degrees of fire, giving a strong one at the last. By this means we had a little black oil swimming upon the spirit, which was also dark and muddy, as if incorporated with some more oil. The weight of both these liquors was twenty three grains, besides which there stuck to almost all the upper part of the retort a thin film of oil, which together with a streak of the like reaching to the bottom of the receiver, we estimated at three grains more, and so reckoned twenty six grains for the weight of the whole ascended matter. The caput mortuum amounted to full the remaining weight of two ounces. The empyreumatical liquors, that came over, smelled much like those of harts-horn, and the spirit was found to belong, as we expected, to the tribe of urinous ones, or, as many now call them, volatile alcalies. For it readily hissed and produced bubbles, with good spirit of salt, turned syrup of violets green, and being dropped into solution of sublimate, turned that white; to omit another way or two, by which I examined it. The oil, that stuck to the retort, and which was foetid, like that of harts-horn, did easily dissolve in dephlegmed spirit of wine, and afforded a reddish brown solution. The caput mortuum was very black, and some grains of it were found readily enough dissoluble in spirit of vinegar. Being calcined in a well covered crucible, with a strong fire, (for a moderate one will not do it, unless it be long) we reduced them to be purely white, and to a weight less by some grains than an ounce and $\text{z}iii.$ and we found, as we expected, that being pulverised, this calx tasted hot and bitterish upon the tongue, like good calx vive, and was not only of an alcalisate, but a lixivial nature: for besides that it presently turned syrup of violets green, it quickly afforded an orange coloured precipitate, with solution of sublimate.

STRANGE REPORTS,

IN TWO PARTS.

Addressed to a Virtuoso, Friend to the AUTHOR.

ADVERTISEMENT.

I PRESUME, Sir, you may yet remember, what I wrote about the nature and scope of my collection of *Strange Reports*, in an essay, which takes its title from them; and which I was encouraged to make by the example of *Aristotle* *. And therefore I shall desire, that to save your trouble and my own, that paper may serve for a preface to that which follows. About which, supposing this request to be granted, I shall need to give you at present but this short advertisement; that for distinction's sake, I thought fit to divide the ensuing particulars into two parts, because they are indeed of two sorts; one relating to things purely natural, and the other consisting of phænomena, that are, or seem to be, of a supernatural kind or order.

THE first set of particulars belonging to each of the two forementioned parts has prefixed to it the title of the first section, though it be not at this time attended by a second; because it is designed, that, God permitting, it shall be so hereafter, when I shall get time to pick up out of my *Adversaria*, and other memoirs, particulars fit to have placed in the list of *Strange Reports*.

I MUST likewise give you notice, that you are not to expect the second part at this time; discretion forbidding me to let that appear, till I see what entertainment will be given to the first part, that consists but of relations far less strange than those that make up the other part.

STRANGE REPORTS.

PART I.

SECTION I.

RELATING to a judicious virtuoso, that a physician of *Brussels* a while since affirmed to me, that he himself had prepared three or four resuscitable plants, one of which he had presented to the marquis of *Castel Rodrigo*, now governor of the Spanish Netherlands, where this virtuoso had not long since been: relating this, I say, to this gentleman, and enquiring of him, whether he had seen this resuscitable plant; he answered me, that he had never seen nor heard of it; but told me on this occasion, that coming to *Deal* with an apothecary of *Namier*, if I misremember not the

* This famous philosopher in his little tract, whose title some render *De Mirandis Auditionibus*, scrupled not to comprise without method divers reports, uncertain or fabulous, nor to insert several, that were not so cautiously admitted, as those recited in the following collection.

the name, much esteemed for his extraordinary skill in chemistry about some choice preparations, wherewith this man's shop was furnished, the apothecary told the virtuoso, that he had really prepared resuscitable plants, a different way from that which others pretended to, and that he could prepare a great variety of them. And when having enquired of the virtuoso, whether he himself had seen any of these prepared plants, he assured me, that he had seen not only some, but many. I then upon farther enquiry, how they appeared, learned, that the chemist had divers of them in distinct glass bottles; that the apparitions, that were exhibited, shewed not the peculiar colours, but only the shape of the plant; but this so genuinely, that he could perfectly distinguish, and easily know it to be such or such a plant, instancing particularly in *carduus benedictus*, and *camomile*.

And the difference betwixt this way of exhibiting plants, and that which is mentioned by *Quercetan*, and pretended to by others, I found by this gentleman's answers, to consist chiefly in these two things: the first, that the apothecary's plants did not, as the others, seem to grow up into the air included in a sealed vial, but were seen as growing in a clear liquor, wherewith the bottle that contained it was almost filled; and the next, that whereas to make the apparition, mentioned by *Quercetan*, and others, the application of an actual heat (as that of a lamp, or the sun-beams, or the like) is affirmed to be requisite, upon the absence of which the phantastical plant relapses into its ashes; in the formation of the apothecary's vegetables, he doth not employ any actual heat, but (which may seem more strange) only the shaking of the bottle; for upon that agitation, the prepared ashes or powder being raised from the bottom, and dispersed quite through the liquor, when the glass is set by in a quiet place, the scattered particles by degrees so convene, as to compose a model of the plant they once belonged to. And heat not being requisite to their formation, these plants do not quickly, as the Polonian physician's fantastic vegetable, recorded by *Quercetan*, fall back into a powder; but, if let alone, continued a great while, until the preparer think fit by a gentle agitation of the bottle, to dissolve the loose contexture of it.

RELATION II.

I met the other day with a very intelligent person, well versed in chemistry, not credulous, and in a word very well worthy of credit, who assured me, that he had himself seen a few years ago at *Mentz* in the hands of one monsieur *P*—r, a gentleman of *Switzerland*, and a virtuoso, a piece of glass about the bigness of a shilling, or somewhat bigger, which was red and pretty transparent like glass of antimony made *per se*, and which this monsieur *P*. affirmed to the relator, that he hammered before the present elector of *Heidelberg*, (to whom, I told him, I had the honour to be known, and) by whom the relator was about that time employed. And this monsieur *P*. being his intimate acquaintance, and perceiving, that he was (as he well might be) indisposed to believe so strange a thing, after he had confessed the glass to have been given him by an excellent chemist in his country (*Switzerland*); this gentleman, I say, at the relator's earnest request, gave him leave, for his satisfaction, to lay the piece of glass upon an anvil, and to strike seven or eight strokes with a hammer upon it; by which means he found, that though it was not malleable (at least in the state it then was) like nealed silver, since it began to crack at the edges like silver, that is over-hammered; yet it did really stretch under the hammer, growing more thin on the beaten part, and having visible marks or impressions made on it by the edge of the hammer.

RELATION III.

A pious and learned schoolmaster, that ventured to stay in *London* in the great plague 1665, and was much employed, as some friends of mine, that knew him, and commended him, assured me, to visit the sick, and distribute alms and relief to them, went indiscriminately to all sorts of infected, and even dying persons, to the number, as he told me, of nine hundred, or a thousand; and being asked by me about the infection of other things than walls, he told me, that being once called to administer some ghostly comfort to a poor woman, that had buried some children of the plague, he found the room so little, that it scarce held any more than the bed whereon she lay sick, and an open coffin, wherein he saw her husband lie dead of the same disease, whom the wife soon after followed. In this little close room they affirmed to him, that the contagious steams had produced spots on the very wall; and when I asked, whether he himself had seen them, he answered, that he had not; but yet was inclined to believe the thing to be true, not only upon the score of the relators, but because he had observed the like in his own study; which being divided only by a wall from some rooms of a house, which the owner had turned into a kind of a pest-house, and in which numbers had died in a short time, he took notice, that the white wall of his study was (since the sickness raged, without any other cause that he could imagine) blemished in divers places with spots, like those of infected persons. When (to add that upon the by) I enquired what antidote he used, he replied, that next the protection of God, which so many sad objects made him the more fervently implore, and a constant fearlessness, the only preservative he used, besides good diet, were half a spoonful or a spoonful of brandy five or six times a-day, especially when he went into infected places, and the bigness of a small nut, or less, of a root of Spanish angelica, of which he held in his mouth the quantity of a pepper-corn, or somewhat less, as often as he thought there was need.

RELATION IV.

January
25.

AN ingenious person, and very worthy of credit, informed me the other day, in answer to some questions that I proposed to him, that he was employed some years ago by a German physician (whose name he told me) to distil a certain mineral not unknown to me, which he performed in a naked fire, with so good success, that he had from about half a pound of the mineral, near *ziii.* of the liquor: this he included in a glass with a bubble, and a slender neck like one of my weather-glasses; but though the liquor at first reached not above the bubble, but only filled it to the bottom of the pipe; yet as the moon increased, this liquor, as the doctor expected, by degrees expanded itself in the glass; so that about the full-moon, it reached about an inch into the pipe, and upon the decrease of the moon, it subsided by degrees to the bottom of the pipe. And when I asked, whether the vessel were carefully stopped; he answered, that it was not only so, but hermetically sealed like one of my thermometers with spirit of wine, which he had seen. This the relator averred to me upon his own observation; and being desired, he readily gave me a description of the mineral, and a direction where to procure it, (which I am now endeavouring to do) adding, that the same doctor made the like trial with another mineral akin to this, with which my having heard, that such an experiment had been done, gave me occasion to propose him the question.

RELATION V.

AN inquisitive traveller, that not long since waited on a German prince addicted to chemistry, and was employed by him in his private laboratory, being asked by me some questions about ore of bismute or tin-glass, whereof there is said to be a mine in that prince's territories, and in particular, whether he had observed any thing of the
varying

varying bulk of a strange liquor obtainable from it; he answered me to this effect, that he had had occasion to make many trials upon this mineral, and that particularly, by his prince's command, he had distilled a considerable quantity of a certain sort of it, (because it yields but very little spirit) and that he thereby obtained a liquor, which being by rectification freed from its superfluous phlegm, amounted to about half a pint. This liquor was put into a vial, which it almost half filled. This vial being exactly stopped, was set aside in a quiet place, where, (as the prince expected) as the light of the moon increased, from the new moon towards the full, so this liquor gradually swelled, and that not in a hardly perceptible degree, but very manifestly and considerably; so that when the moon was full, the liquor reached almost to the top of the glass, and during her wane, as the light decreased, so did the bulk of the liquor, which was always least at the new moon. I asked him, if any trial had been made, whether the weight of this spirit varied with the bulk, and he frankly confessed to me, that it had not come into his mind; but for what is above related of the increment and decrement as to quantity he affirmed to me, that himself, as well as his prince, had several times observed it; and he also readily told me the way he used in making the distillation, which, he said, exacted an intense degree of fire.

RELATION VI.

AN inquisitive person, that having gone through his studies in the university, travelled through divers countries, to make himself the more fit for the profession of physic, answered me, that having resided for some time in *Prussia*, he had more than once or twice (and that in differing places) observed, as others in his company also did, that the fishermen in breaking the ice of long frozen places, and taking out thence considerable masses of ice, did several times find in them swallows, sometimes numerous enough, that were so inclosed in the ice, that unless by breaking, or thawing it, they could not be gotten out of it. And he further answered me, that when these lumps or masses of ice came to be thawed in their German stoves, the swallows, that lay as dead before, would revive, and perhaps fly about the room, but did not long survive their recovery out of their insensible state, some dying again in few hours, others the next day, or perhaps the third; but few or none, that he observed, living beyond the fourth or the fifth; which immature death my relator judged to be caused by their having no appetite to eat, which inappetency made them die starved. But as the conjecture may be true as to those, that lived for some days, so it seems not like, that those that perished in few hours died merely of hunger; and as for them, that were starved to death, I should suspect, that they were starved, not so much for want of appetite, as for want of such animals as they used to feed on, especially flies, which they could not get in winter.

RELATION VII.

AN inquisitive gentleman lately returned from *Jamaica*, where he was employed by the governor to make discoveries of natural things, answered me this morning, that he had seen in that island great number of trees, that bear the silken cotton; that he found many of them to surpass in bigness and height the larger sort of our English oaks; and that on a mountain, that many went to visit, out of curiosity, to view a stupendous silk cotton tree, he saw its bulk, and many affirmed to him, and it was the general tradition of the country, which he saw no cause to disbelieve, that this prodigious tree was in the body no less than twenty one yards about, that is, more than sixty foot in compass.

THE same curious traveller told me, he saw a canoo made of the hollowed trunk of one of these silk-cotton trees, which, after all that had been taken off, to give it the shape of a vessel fit for service, was thirty foot about, and of at least a proportionable length.

RELATION VIII.

A MERCHANT, rich and judicious, and more addicted to letters than is usual to men of his calling, being returned into *England* from some of the remoter parts of the *East-Indies*, to satisfy my curiosity about a strange tradition of several navigators about a more than one way extraordinary in-draught of the sea on the coast of a great island of the southern ocean, sent me the ensuing relation, which though it contains something manifestly fabulous, but easily distinguishable from the rest, I give you in the relator's own words, being unwilling to alter any thing, till I can see him again, and propose my scruples to him.

AT *Campar* and *Racan*, on the east coast of *Sumatra*, is in the river's mouth (to a certain distance) at each new and full moon, a violent in-draught of the sea (called *Bunna*) which approacheth with an hideous noise, and mountain high, so that whatsoever opposeth it, perisheth. Its approach is in three parts; the first high, but not so terrible; the second is high, black and horrid; the third is low, and of gentle motion: before its approach, it giveth so fair warning, that the people may eat, and bathe themselves, before they weigh anchor; but when they weigh, they must row hard against it, and when its fury is past, follow with it, till they return to their anchor place. The true reason whereof the inhabitants cannot discover: but (as if *Greece* only were not the mother of fabulous traditions) these poor natives fabulize, that at *Campar* (where is the greatest *Bunna*) in former ages, there was a princess, who, to shun the rape of an insolent *Cassree* slave, ran into the sea's mouth; but the slave still pursuing her, and after him the princess's little dog, all perished; and thus (by a new metamorphosis) these three waves perpetuate their commemoration. That afterwards a bold fellow, hoping to divert this *Bunna* from *Campar* (by advice of some wizards) rowed up against that first part of the torrent, and filling a bottle of its water, which he immediately stoped up close, he betook himself to *Racan* (not far distant) and poured it out into that river's mouth, which brought the *Bunna* thither also, though it left not *Campar*; but that fellow suddenly after dying, none durst since attempt the like, else the natives fancy it may still be done.

My humble opinion is (adds my relator) that the mouths of those rivers being choaked up with their sand-banks, and so rendered very shallow; when the great spring-tides come roaring over those shoals (at the new and full moons) out of the *Malacca* streights, the first influx is irresistible by such small vessels as use that port (especially if attended with dark weather, or stormy gusts) so that they are forced to weigh and bear up against it, for fear of being stranded and split. In which sentiment I rest, till I can attain a more prevalent reason.

RELATION IX.

A GENTLEMAN, that had travelled far, and observed much, related to me, that, being off the coast of *Mosambique*, between the 20th and last days of *September*, the captain of the great Portugal ship they were in, walking to and fro upon the deck, spied, a great way off, a very little dark cloud, or blackish spot in the sky: whereupon, though the weather were fair, he made all the haste he possibly could to provide for a great storm, by taking in the sails, &c. And though for a while the sky continued clear, and they had no signs of an imminent change; but that, when the

cloud approached, the wind, that had till then filled their sails, ceased, and the sea became calmer than before: but presently after they had a furious hurricane, which turned their ship quite round many times one after another, as if it were an aerial whirl-pool, which lasted for above two hours, and then left them, seeming to have a progressive motion, as whirlpools in rivers often have.

RELATION X.

AN ingenious practitioner of physic, accompanied by one of the same profession, assured me with great asseveration, that some while since, being at a place in the country near *Amsterdam*, where there lived a kind of a farmer, who (though illiterate enough) was reputed very curious; this person shewed him, among other things, a considerable quantity of quicksilver, that was altogether of the colour of gold. And, to answer my scruple, this relator added, that the colour did not belong only to the surface of the whole mass; but having purposely (with water) divided it into many globules, each of them retained the same rich colour. And he further told me, that the possessor of this yellow mercury having put some of it over a fire in a convenient vessel, it quickly lost its fluidity, and was precipitated into a red powder; about which he hoped to learn some notable things at his next visit to the author: but that having been too long delayed, when he came to the place again, he found, to his great grief, that the master was dead, and his relations were, or pretended to be, ignorant of his secrets.

A VERY learned and experienced physician made me a visit to give me notice, that a few days before he had received one in the night from a couple of strangers, one of whom, by some things that he saw him do, he judged to be (what they call) an adeptus, who, besides a thing far more rare and valuable, shewed him, as a curiosity, a running mercury of a lovely green. And when I asked my judicious relator, whether he had broken the fluid mass into drops, to observe, whether the colour were that only of the surface, or of the whole mass? he answered, that he purposely laid it upon a rough body, as a carpet, and found the globules, whereinto it was by this means divided, to be of the same fine green, that had beautified the whole mass.

THESE relations, though they had come to me from less credible persons than those I received them from, I should not hastily have rejected, because of some odd and fine colourations of running mercury, that I have myself observed, but here forbear to mention, because they belong to another paper.

THE
GENERAL HISTORY of the AIR
DESIGNED and BEGUN.

Advertisement of the Publisher to the READER.

THE design of the following papers the author's own preface will acquaint thee with. And though, as thou wilt there see, his expectation of assistance (in a work too great for one single man's undertaking) from others failed him, yet I doubt not but his own experiments and collections would have made this treatise much larger,

larger, before it had been published, had his health allowed him opportunity: but that permitting him not so much as to review these papers, or range them into that order, which would be most advantageous, thou art not to wonder, if thou findest some defects, some dislocations, and other faults, in this publication, which the author's last hand would have prevented. The negligence of transcribers has let slip the characters of relators, and names and places of authors, from whom several of the particulars in the following papers were taken: nor could it be hoped that the author's own memory (were he in a state of health fit to be troubled with it) should, after so long a time as this collection has been making, and in that variety of men and books he has had to do with, be able to retrieve them. But this will be no great loss to the learned world, which is sufficiently acquainted with his great caution, and will make no difficulty confidently to rely upon his unaffected candor and sincerity. I know not how much some other parts of his noble (and always busy) designs for the advancement of knowledge, and the benefit of mankind, may suffer by that tenderness of his constitution, which the importunity of his friends can hardly prevail upon him to withdraw from philosophical cares. But this he has ordered so, that, imperfect as it is, one cannot call it deficient; since, the foundation being here laid, and the draught made, every one may, if he please, add towards the compleating of the building, I will not say with materials equal to what his sagacity and laboratory used to afford; for we must not expect to find in every age a man able and ready to lay out so much cost, pains, and skill, frankly, for the improvement of natural philosophy, and the information of the world, as he has done. The scheme of titles, under which these materials for the history of the air are ranged, is somewhat different from that printed by him several years since, and distributed amongst his friends. But this is without any prejudice to the main design, since whatsoever any one hath collected under those heads, will be easily reducible to these, which in a more natural order are more comprehensive. In that first draught he followed my Lord *Bacon's* advice, not to be over-curious or nice in making the first set of heads, but to take them as they occur. But now that thus much comes to be published, which perhaps may serve to some men as a common place for the history of the air, the titles have been a little more increased, or methodized, to which any one may add as he finds occasion: only in these the reader is desired to observe,

I. THAT under the title of mineral substances are comprehended earth, and all other fossils, to avoid multiplying of articles.

II. THAT when any mixed body is ranked under animal, vegetable, or mineral substances, it is put under that of the three, which either it partakes most of, or to which most is owing in the present experiment, or which in its own nature it most resembles.

III. THAT it is not by an over-sight, that lightning is put under two different titles; for in one it is considered only in reference to the sight; in the other it is considered as the product of sulphureous or inflammable effluvioms taking fire, with the strange effects it produces; which may be an example of putting the same thing, with different views, under different heads.

WHAT is above said, was written whilst the author was living, to which it is necessary now to add, that the titles, as here printed, and the order of the papers, as now ranged under them, were shewn to the author, and approved by him, as fitter for the general history of the air, than those he had formerly printed. So that, reader, thou hast these papers as they were prepared and ordered to be published in his lifetime, and they had then gone to the press to be printed, just as thou now receivest them, had not the publisher the last winter been hastily called out of town.

The P R E F A C E.

THE continual use of the air is so absolutely necessary to our life; the good or bad temperature of it is so important to our health; and the scarce evitable presence and powerful pressure of it, has so great an interest in many of the phænomena we meet with here below, and even in divers, where its agency is not suspected; that among mere bodies there are perhaps few subjects, that more deserve our curiosity, whether as we are animals, or as we are naturalists. Upon which account I can scarce think that any thing, that conduces to the fuller knowledge of a body so diffused, so necessary, and so powerful, is fit to be despised, or is unworthy to be preserved in writing.

AND therefore, though I have formerly had occasion to treat, in distinct tracts, of some of the qualities or affections of the air, as its gravity, springiness, &c. yet I found myself inclined to contribute further to the knowledge of that vast and useful subject, by setting down some memorials, partly out of my own observations and trials, and partly out of those I had from persons of good credit, concerning some causes and effects of the changes of the air, and consequently concerning several of its qualities, that were requisite to be taken into consideration in a work of that nature. And not content with this, though my own studies and affairs would not permit me to prosecute myself the design I am going to mention, yet, thinking it might be a very useful thing, in reference both to philosophy and physick, that a natural history of the air (though at first it should prove but a very imperfect one) were faithfully compiled, I propounded the design to some virtuosi, that seemed to relish it, and undertook to be assistant in it.

AND, to facilitate their work, I drew up a set of heads and inquiries of that sort, which in another paper I call titles of the first classis or order; which, though purposely set down without any anxious method, were comprehensive enough to have a good number and variety of particulars conveniently referred to them. But afterwards finding the persons, to whom I had committed these schemes, to have been for many years very unmindful of their promises; I did, on this discouragement, lay aside, not only the hopes of a general history of the air, but what I had already written about the changes of that body.

AND, upon the same accounts, those scattered notes lay many years in loose neglected papers, till at length the curiosity and desires of some virtuosi, that knew I had gathered some remarks, though few and incoherent, touching some qualities of the air, obliged me to draw together those, that without a troublesome search I could retrieve, offering themselves to promote the design, that others had abandoned. The desire to gratify these inquisitive men, and the conviction I am brought under, by such reasons as are mentioned at the beginning of this paper, that scarce any truth, whether historical or doctrinal, that relates to so important a subject as the air, is unfit to be preserved, prevailed with me, rather to chuse a very disadvantageous way of setting down what I have to deliver about it, than suffer the loose observations I had occasion to make about some phænomena and qualities, and especially the changes of the air, to be lost. And therefore, though I have not the leisure to methodize my incoherent notes, and much less to weave them into continued discourses; yet, rather than let them perish, and disappoint those that will have them such as they are, I am content to refer to some of the titles prefixed to this treatise, as to a kind of common places, what my memory, or some old notes about divers

things relating to the air, and especially to the causes and effects of its changes, supply me with in reference to that body.

AND, upon the like account, I have not strictly confined myself to the mention of my loose observations, and those that I have been furnished with by answers to the questions I put to divers travellers and navigators; but I have also cast in several pertinent passages, that chanced to occur to me in the reading of some voyages, and other books, especially such as are either out of print, or are but in few hands, or else are not extant in those that are called the learned languages. And that those virtuosi, that are willing to contribute their industry to carry on the design, that was at first proposed, might have some heads whereunto to refer what shall occur to them; I thought fit to promise to my papers the abovementioned scheme, or rough draught of the general history, (which after many years I chanced to recover.) I have also thought fit, that, under three or four titles, my collections of particulars should be somewhat large and methodical, to afford the same persons some specimens of what I should have thought requisite to do upon particular subjects, if I would have ventured upon such a task, as to write a natural history of the air.

I AM not ignorant, that I expose myself to censure, for suffering to pass out of my hands memoirs so maimed and imperfect, that several of the subjects mentioned in the scheme of titles are left altogether untouched; and those, that are particularly mentioned, are for the most part touched upon but lightly. But the chief (though not perhaps the only) reasons, that kept me from being silenced by these considerations, though I confess them to be weighty, were these: first, that, not pretending to write the history of the air, but only some memoirs of it, I might, without incongruity or indecency, contribute what had occurred to me in reference to some of the titles, though I left the others to those, that had made experiments or observations about them. Next, that having, through the fraud or negligence of some persons, lost sundry loose papers, that I had provided for the history of the air, my unwillingness, that the rest should undergo the same fate, invited me to impart them to many, as the best expedient to secure them. To which I, thirdly, add an inducement, which, though last named, was the first in efficacy, as that which made the other two significant; namely, that I had more than once observed, that when a work of this nature has been once begun and taken notice of, in such an inquisitive and active age as this of ours, it seldom fails to excite the curiosity and industry of others, whom, if the design be any thing well laid, the utility, that it promises, will invite to carry it on.

T H E
G E N E R A L H I S T O R Y of the A I R
D E S I G N E D and B E G U N.

T I T L E I.

What we understand by the Air.

BY the air I commonly understand, that thin, fluid, diaphanous, compressible and dilatable body, in which we breathe, and wherein we move, which envelops the earth on all sides to a great height above the highest mountains; but yet is

so different from the æther [or vacuum] in the intermundane or interplanetary spaces, that it refracts the rays of the moon and other remoter luminaries.

T I T L E II.

Of the constant and permanent Ingredients of the Air.

A Short Answer to a Question about the Nature of the Air, given by Mr. Boyle to Mr. H. Oldenburg.

AS to your question, what I think the air to be? I shall in the first place take it for granted, that by the air you mean not, either the pure element of air, which some, nor that ethereal or celestial substance, that others (upon what grounds I must not here examine) assert; but that, which I am wont to call the atmospherical air, which is that common air we breathe and move in.

BUT though I know you too well to suspect, that you design any ambiguity in your question; yet I shall not adventure to answer it, till I have premised a distinction that is not usual: for, according to my thoughts, the air may be taken either for that, which is temporary, (if I may so call it) or in a transient state; or that which is lasting, and in a permanent state. This distinction, which perhaps you looked not for, I shall illustrate by this example, that if you sufficiently heat an æolipile furnished with water, and stay a pretty while to afford time for the expulsion of the aerial particles by the aqueous vapours, you may afterwards observe, that these last named will be driven out in multitudes, and with a noise, and will emulate a wind or stream of air, by blowing coals held at a convenient distance, like a pair of bellows, and by producing a sharp and whistling sound against the edge of a knife, held in a convenient posture almost upon the orifice of the pipe, whence they issue out. But this vapid stream, though in these and some other things it imitates true air, whilst the vehement agitation lasts, which the vapours it consists of received from the fire; yet in a very short time, especially if the weather, or the vessels it enters into, be cold, loses the temporary form it seemed to have of air, and returns to water, as it was at first.

THIS premised, I come to speak directly, but dare not do it confidently, to your question: for though possibly I may have made as many trials as another about the nature of the air; yet I freely confess to you, that I much suspect there lies yet something concealed in it, that needs a further discovery, which may perhaps be made by further trials. But in the mean time (not wholly to baffle your curiosity, since it is so modest, as to desire to know of me, not what the true nature of the air is, but what I guess concerning its chiefest property or attribute) I will acquaint you with some of the thoughts I long ago had, and which I yet took upon myself, and desire to have them looked upon by you but as conjectures, entertained only till farther discoveries confirm them, or suggest better in their room.

It seems then not improbable to me, that our atmospherical air may consist of three differing kinds of corpuscles. The first is made of that numberless multitude and great variety of particles, which, under the form of vapours or dry exhalations, ascend from the earth, water, minerals, vegetables, and animals, &c. and, in a word, of whatever substances are elevated by the celestial or subterranean heats, and made to diffuse themselves into the atmosphere. The second sort of particles, that make the air, may be yet more subtiler than the former, and consist of such exceeding mi-

nute

nute parts, as make up the magnetical steams of our terrestrial globe, and the innumerable particles, that the sun and other stars, that seem to shine of themselves, do either emit out of their own bodies, or by their pressure thrust against our eyes, and thereby produce what we call light; which, whether we explicate it by the Epicurean or Cartesian hypothesis, argues a great plenty of a celestial (or some other very subtle matter, to be dispersed through, or harboured in, the intervals of the stabler or grosser corpuscles of the atmosphere.

BUT because you expect from me a distinguishing (and as it were characteristic) quality, which may put a difference between the parts already named of the atmosphere, and those, to which most of the phenomena of our engine, and many other pneumatical experiments seem to be due, I shall add a third sort of atmospherical particles, compared with which, I have not yet found any, whereto the name of air does so deservedly belong. And this sort of particles are those, which are not only for a while, by manifest outward agents, made elastical, but are permanently so, and on that account may be stiled perennial air.

OF the structure of the elastical particles of the air, divers conceptions may be framed, according to the several contrivances men may devise to answer the phenomena: for one may think them to be like the springs of watches, coiled up, and still endeavouring to fly abroad. One may also fancy a portion of air to be like a lock or parcel of curled hairs of wool; which being compressed by an external force, or their own weight, may have a continual endeavour to stretch themselves out, and thrust away the neighbouring particles, and whatever other bodies would hinder them to recover their former state, or attain their full liberty. One may also fancy them like extremely slender wires, such as those of gold and silver, that tradesmen unwind from some cylindrical bodies of differing sizes, on which they were rolled; which pieces of spiral or curled wire may be, as of differing substances and consistencies, so of very differing lengths and thicknesses, and have their curls greater or lesser, nearer each other, or more distant, and be otherwise diversified, and yet all have springiness in them, and (notwithstanding) be, by reason of their shape, readily expansible on the score of their native structure, as also by heat, girations, and other motions, and compressible by an external force into a very little room. I remember too, that I have, among other comparisons of this kind, represented the springy particles of the air like the very thin shavings of wood, that carpenters and joiners are wont to take off with their plainers; for, besides that these may be made of differing woods, as oak, ash, fir, &c. and thereby be diversified as to their substance, they are usually of very various breadths, and lengths, and thicknesses. And perhaps you may the rather prefer this comparison, because it may seem somewhat to illustrate the production of the springy particles of the air: for, to make these shavings, there is no art nor curious instruments required; and their curls are no ways uniform, but many ways differing, and seemingly casual; and, which is chiefly considerable, these shavings are producible out of bodies, that did not appear, nor were suspected, to be elastical in their bulk, as beams and blocks, almost any of which may afford springy shavings, barely by having some of its parts so taken off, as to be thin and flexible enough, and commodiously shaped; which may perhaps illustrate what I tried, that divers solid (and even mineral) bodies, not suspected of elasticity, being put into corrosive menstruums, devoid of that quality, there will, upon the convenient comminution of parts ensuing the action and re-action that passes between them in the dissolution, result or emerge a pretty quantity of permanently elastical fire. But possibly you will think, that these are but extravagant conjectures: and therefore, without adding any thing in favour of them, I shall proceed, and willingly grant, that

that one may fancy several other shapes (and perhaps fitter than these we have mentioned) for these springy corpuscles, about whose structure I shall not now particularly discourse, because of the variety of probable conjectures, that I think may be proposed concerning it. Only I shall here intimate, that though the elastical air seem to continue such, rather upon the score of its structure, than any external agitation; yet heat, that is a kind of motion, may make the agitated particles strive to recede further and further from the centres of their motions, and to beat off those, that would hinder the freedom of their gyrations, and so very much add to the endeavour of such air to expand itself. And I will allow you to suspect, that there may be sometimes mingled with the particles, that are springy, upon the newly mentioned account, some others, that owe their elasticity, not so much to their structure, as their motion, which variously brandishing them and whirling them about, may make them beat off the neighbouring particles, and thereby promote an expansive endeavour in the air, whereof they are parts. And though some of these may, in very cold climates and seasons, prove to be of those, which I not long since referred to temporary air; yet others of them may be so minute and agile, and so advantageously shaped, that, at least in our climate, the air will scarce be so cold, but that the causes, which entertain the agitation, and keep it fluid, may also give a competent motion to particles so well disposed to be kept in it.

AND now, Sir, it will be time to endeavour to proceed to some particulars, that may countenance the conjectures I have hitherto been proposing.

HAVING not now the leisure to prosecute this discourse uninterruptedly, till it be completely finished, I thought it not unfit, not only to set down, in this paper, some of those occurring thoughts and observations of my own, upon this subject, that were the likeliest, unless this way preserved, to vanish out of my memory, and which may serve to recal divers others into it; but also to annex some passages referable to the same purposes, borrowed from such books, as probably I may not have at hand, when I shall resume this treatise. These two sorts of passages make up the following notes, and are therefore to be looked upon but as materially here laid together to be preserved, not so much for themselves (though some of them perhaps deserve not to perish) as in order to the finishing of the designed structure. And though, for that reason, they may often appear very confusedly placed, yet they may seem more incoherent than they are, there being certain transitions, and other things, by which some of them may be so connected, as to be fit to make discursive parts and paragraphs of the treatise they belong to; upon which account it is, that they are put at divers distances one from another, that, if hereafter I have leisure, there may be room for the transitions, &c. by which they are designed to be connected into coherent discourses.

WHAT is above said, in reference to this tract in general, is applicable to those particular parts of it, whether chapters or sections, or other divisions, that follow a line of astericks, such as the ensuing * * * * * employed to separate the unfinished part of the division it belongs to, from the foregoing.

T I T L E III.

Of the Æther in the Atmosphere.

T I T L E

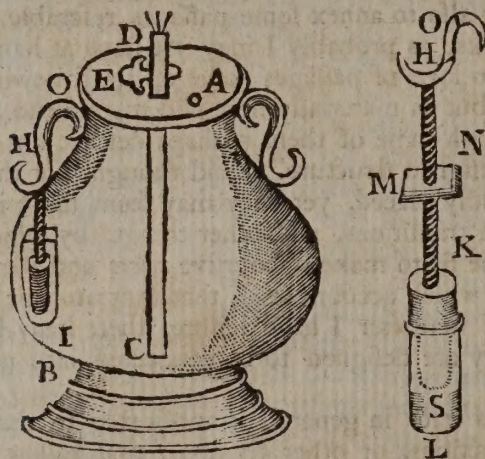
T I T L E IV.

Of the springy Particles of the Air, and the Spring of the Air.

Aerem validè comprimere, aut dilatare.

Casati Me-
chanicor.
lib. VIII.
c. 5. p. 792.
793. &c.

FOLLIBUS luscis aerem pulco ingerentes majorem subindeat que majorem difficultatem percipiunt; quo enim magis aer conclusus à naturali raritate recedere cogitur, etiam majore nisu resistit, neque solum magis densari renuit, sed & se latius explicare molitur. Hinc didicimus & pneumaticos fontes construere, qui spiritu interno urgente aquam in altum elevant, & plumbeas glandes fistulis ejaculari, non pulvere nitrato ignem concipiente, sed aere per vim densato ad antiquas dimensiones recuperandas erumpente. Quoniam verò ingesta jam in conceptaculum non exigua aeris copia difficilius comprimitur novâ aeris accessione, quàm ut manus valeat trifidum rectâ impellere; idcirco trifidi hastulam deformatam in helicem, & suæ matrici insertam, adhibere operæ pretium erit: dum enim manubrio agitante contorquetur cochlea, sensim deprimitur embolus, aeremque ingerit. Ne autem morâ longiore opus sit perpetuâ versatione manubrii, ita cochleæ matrix externam vasis faciem contingat, ut illi adnecti, atque ab eo disjungi valeat: initio enim, quando adhuc levis est aeris modicè compressi resistantia, lamella illa suo foramine interiùs claviculatim striato coherens hastulæ emboli, si à vase disjuncta fuerit, unâ cum hastulâ movebitur: deinde vero, quando jam trifidus aegrè impellitur, lamella illa cum vase connectatur, & non nisi versato manubrio adduci atque reduci embolus poterit, id quod satis lentè perficietur. Rem claritatis gratia in fonte pneumatico explicemus.



Sit vas A. B. ex materiâ metallicâ, in cujus superiore parte labrum, ex quo per foramen A. immittatur in vas aqua, ita tamen, ut non impleatur; aqua enim in vas modicè inclinatum descendens, aerem expellet per tubulum C. D. ubi satis aquæ immisum fuerit, occludatur foramen A. diligentissimè cochleolâ congruente, & convoluto epistomio E. tubus C. D. sit acri impervius ad vasis latus statuatur modiolus cum embolo congruente H. I. & emboli hastula sit connexa cum mobili vasi ansâ H. O.

Porro hastula H. K. perforata sit, & continuo ductu usque ad emboli K. S. fundum pateat aeri ingredienti via H. S. sed foramini S. adjecta sit valvula, quæ aeri

regressum obstruat. Similiter modioli fundo in I. valvula exteriùs apposita aperiatur ingesto aeri transitum præbens; sed aeri intra vas compresso cum nusquam exitus pateat, valvula ipsa modioli foramen I. occludit. Hastulæ verò H. K. exterior facies sit in helicem striata, & lamellæ M. N. tanquam matrici congruat, quæ in M. & N. cochleolis adnecti queat exteriùs vasi, quasi esset ansæ fulcrum.

Ubi immisum fuerit quantum satis est aquæ, cochleolis M. & N. revolutis disjungatur matrix à vase: tum attractâ ansâ H. O. unâ cum lamellâ M. N. attrahitur embolus K. S. & per apertum ductum H. S. ingreditur aer, modiolum implens. Impulso deinde embolo, valvula ad S. clauditur, & aer ex modio per patentem valvulam I. ingeritur in vas; ex

quo nequit exire, neque aquam propellere, clauso scilicet epistomio E. & foramine A. qua propter comprimitur, & densatur; ideoque attracto denuo embolo K. S. inclusus vasi aer se latius explicare connitens valvulam I. valide applicat foramini modioli, sibi que exitum obstruit. Toties adducitur atque reducitur embolus, & aer ingeritur, quoad magna premeendi difficultas percipiatur; ubi eò ventum fuerit, tunc lamella M. N. iterum vasi adnectatur suis cochleolis; nec jam embolus rectà adduci potest; sed arreptum in O. manubrium versatur, & embolus intra modiolum circumactus sensim attollitur, qui deinde revolutus in contrarium manubrio deprimitur, & multà vi aer in vase comprimitur. Laxato demum Epistomio E. compressus in vase aer aquam exprimit per tubum C. D. primum quidem vehementius, subinde remissius, prout aeris vis elastica sensim longuescit.

Hoc idem quod de aere intra vas comprimendo ad aquam evibrandam comminisci placuit, servatà analogià, dicendum est de aere, tum conatu manùs rectà trusillum impellentis, tum ope cochleæ similiter conformatæ, intra conceptaculum comprimendo, ut ex fistulâ deinde multà vi emittatur plumbea glans, ubi reseratus aeri exitus illum subitò dilatari permiserit. Quin & pneumatica hujusmodi tormenta citrà conceptaculum aeris compressi construere non inutile accadat, si, quemadmodum nostrates pueri surculos sambuceos fungosâ medullâ exhauriunt, & utraque tubuli extremitate papyraceis globulis obstructâ, alterum globulum congruo cylindro propellunt, atque inclusum aerem densant, quoad aeris vim elasticam & impellentis manus conatum non ferens extremus alter globulus edito scloppo expellatur; ita ferream fistulam longiorem paraveris, cujus alteri extremitati immittatur plumbea glans obducta papyro, aut simili materiâ, ut exquisitè tubi osculum implens demum universam aeris vim excipiat, alteram extremitatem aliquot spiris ambiat cava cochlea, quam impleat cylindrus ferreus in congruentem cochleam deformatus; si enim hujusmodi cylindrus vix brevior fuerit, quàm fistula, & apto manubrio convolutus in fistulam sensim immittatur, totum aerem, quo fistula replebatur, ad exiguas spatii angustias adiget, ex quibus magnâ vi demum quæ data porta, erumpens ejaculabitur plumbeum globulum.

T I T L E V.

Of the magnetical Particles in the Air.

T I T L E VI.

Of the Destruction, Generation, Absorption and Extrication of the Air.

New Experiments about producing of Air, and examining the Bodies produced.

THAT the air has a great interest in the production of many phænomena of nature, either not formerly known, or not formerly ascribed unto it, as the chief agent, if as any at all, has been, I suppose, sufficiently manifested by our own experiments, as well as by those published by abler writers.

THAT also the air is necessary not only to the well-being, but to the very being and motions of the generality of animals, will be easily deduced from those trials, whereby we have made it appear, that animals, whose blood is hot, may be killed in our engine by the withdrawing of the air in about one minute of an hour; and that even those minute creatures, whose blood or analogous juice is cold, will, for the most part, without excepting cheese-mites themselves, presently lose all their visible motions, upon the recess of the air, may appear from our experiments about respiration.

WHEREFORE the air being a body so important in our speculations of nature, and so necessary to the continuance of our lives, I could not but think it deserved, that we should solicitously enquire, whether it may or may not be produced by art: for if it can be so by any, not very uneasily practicable ways, the discovery may not only help us to explicate some difficult phænomena of nature, but may afford us, among several other uses, that of enabling us to supply divers, if not also submarine navigators with fresh air produced under water, and thereby lengthen their staying in places, where the continuance of it may be of great use, both speculative and practical.

UPON these and the like motives, I resolved, notwithstanding the difficulties I foresaw my curiosity would meet with in so new an attempt, to try what I could do. But before I relate the success of this attempt, I must premise a couple of necessary advertisements.

AND first, when I here speak of production of air, I desire to be understood in a familiar sense, meaning, by that expression, the obtaining a sensible quantity of air from bodies, wherein it did not appear, before they were handled after our way, that so much air, if any at all, was pre-existent. This I say, because I would not in this place needlessly engage in the controversy about the ingenerability (as they speak) or the mutual transmutation of the bodies, that are called elementary: for though I am not sure, but that some of our experiments may argue a new and real production of air, or a generation of it in the stricter sense, yet I shall now employ the words generation and production, in the large and popular acceptation, and would signify by them, as I lately intimated, the obtaining of a sensible quantity of aerial substances from bodies, that did not appear to have it; whether this obtained substance were due to an extrication and union of aerial particles latent in the pores of the bodies, that afford it, or to a real production or generation of air, no where existent antecedently to our experiments. And this is the first of my two advertisements.

THE second is this, that among the difficulties I foresaw, in making experiments suited to my design, I looked upon it as one of the greatest, though the least obvious, that to satisfy such a disposition as mine, that is naturally prone enough to question things, it would be requisite for me to consider, and, if I could, to determine, by appropriated trials, whether the fluid substances my experiments might afford me, deserved the name of air or not. Wherefore I saw myself obliged to increase my task, and so direct my enquiries, that in the first place they may afford me sensible portions of such a substance, as in a popular sense may be stiled air, whether these obtained substances ought to be looked upon as true air or no. So that my intended disquisition would naturally consist of two parts, whereof the former was to contain the ways of producing that, which seems air; and the other to propound those of examining, how far the produced substance is endowed with the qualities, that are judged to belong to air as such.

BUT in regard, that I thought it most convenient so to contrive my experiments, as to make such of them as I could to serve me, both to produce air, and to examine it, I shall be more than once obliged to mingle the two parts of my disquisition, and reserve for the latter of them only those few trials, that concern purely the examen of the produced air.

AND upon this score it will be seasonable to take notice in this place, that forasmuch as there are divers qualities ascribed to air, which to me seem but accidental, and not universally to belong to air as such; I have not observed any one attribute, that I think, to be so much the property of air, and so fit to distinguish its true particles from aqueous vapours, earthy exhalations, and the effluvia of other bodies, as a durable elasticity or springiness. And therefore I shall henceforth employ that as

the

the chief criterion, whereby to constitute a portion of matter aerial, and discriminate it from other flying and fluid substances, and consequently to allow or deny it the title of air.

Now among the several ways I thought of, whereby to produce air, those I judged fittest to put in practice were these. 1. By fermentation. 2. By corrosions and dissolutions of bodies. 3. By boiling of water and other liquors. 4. By the mutual actions of some, especially saline bodies, upon one another. 5. By the analyses and resolutions of certain substances.

EXPERIMENT I.

ON *January 17* we conveyed into a long and large tube some filings of steel, and as much water as was thought convenient to dilute the oil of vitriol, which we also conveyed in a peculiarly shaped glass, sealed at both ends, but with a hole opened near one of them; the external tube, and the water in them being exhausted, and the mercury in the gage, which we had also included, being so far impelled up into the open leg, that there was scarce any at all left in the sealed leg: this, I say, being done, the external tube was by our way exactly closed; and then the oil of vitriol being by little and little, and at good intervals of time, poured out of the internal tube, to actuate the water, there were produced exceeding large bubbles by the action of the solvent upon the metal, which also produced a sensible heat, though not a great one. When this conflict had lasted a while, we observed, in compliance with the chief scope of this experiment, whether there would be any springy air produced by all those bubbles; and we perceived, that there seemed to be so much of it generated, that at length the mercury in the gage was impelled to the very bottom of the open leg, and the air included in the other seemed to be more compressed than it had been, when it was put in by the weight of the atmosphere. But to try, whether this spring (wherein the warmth formerly mentioned might be suspected to have for that time some interest) would continue, I removed the tube into another room, where was no chimney; and coming to look on it the next day, did not take notice of any sensible alteration in the gage; and with the like success I visited it for three or four days. But then coming one day to look upon it, I found the mercury in the gage to have ascended about an inch and an half, and about that quantity of water to have got into the sealed leg; which inclined me so much the more to suspect, that this change in the gage might have been accidental, a boy having unknown to me removed the tube from its wonted station, to place somewhat else there, without doing it heedfully enough. And this conjecture seems the more likely, because I have not seen any notable change to have happened in the gage from that to this, (which is the 25th of *January* at night) the mercury in the open leg being about one inch and an half.

EXPERIMENT II.

MARCH 8. A glass vial holding about a pint (by guess) was filled with wheat flower, and as much water as was sufficient to drench it well. Afterwards the orifice was exactly and strongly closed with a cork, and an excellent cement: the glass was set in a warm place of the laboratory, because of the coldness of the season; and having stood there a fortnight bating one day, it this morning broke by the mere dilatation of the included matter, whose visible part was last night observed to leave a considerable part unfilled beneath the cork. Notice was taken by the laborant of the event of this trial by a noise, which was no louder than one made upon the bursting of the glass

into several pieces. To my taste the included matter was but a little fourish, but another afterwards judged it to be manifestly acid.

EXPERIMENT III.

MARCH 9. Having on the 23d of *February* put into a pretty large bolt-head a convenient quantity of bruised raisins, with as much water as I thought necessary to make them ferment; and having caused the air to be carefully pumped out, and taken sufficient order to keep any from forcing or stealing into the glass, I set it in the laboratory, that the warmth of the air might facilitate the fermentation. At the end of four or five days, it did not appear by a mercurial gage, (which had been purposely inclosed together with the raisins) that there was generated any springy substance. But being hindred by several occasions from looking after this glass from time to time, it seems the contained liquor fermented more violently than the time of the year would have made one expect: for about four of the clock in the afternoon, nobody being in the laboratory, the glass flew in pieces with a loud noise like the report of a pistol; which alarming a domestic of mine, that was in a chamber not far off, made him hasten to the laboratory, where he found the raisins thrown all about, and the middle part of the bolt-head (for the bottom and the pipe were entire enough) scattered into such little pieces, that they seemed almost to be vanished.

EXPERIMENT IV.

ON the 22d of *February* I filled a glass, that had a somewhat wide mouth, and might hold by estimation three pints (or pounds) of water; to which that liquor, and a convenient quantity of bruised raisins upon the orifice of the glass, were tied to the neck of a pretty large bladder, out of which the air having been diligently expressed, it was strongly fastned to our glass with one of our close cements; so that by squeezing the bladder, we could not perceive, that any air could get in or out. Then, this done, we left the glass in a convenient place in the laboratory, till the 8th or 9th of *March*; and then finding the bladder to be plumped up, we would have tied up the contained air, but could not do it by reason of an imperceived hole, perchance made with the point of a pin, by some one of them that handled it. Wherefore taking off this bladder, we caused another, that was very limber, to be put on after the manner newly described; and yesterday morning we found it, though by estimation it may hold about two pounds of water, to be so full of air, that we could not without difficulty, and losing a pretty deal of the contained air, tie the bladder very close near the neck of it.

AND to try, whether this same mixture would continue to produce air, (whether fermented or not, I must not here dispute) I caused another bladder to be fastned to the same glass as before, and found it this morning, *March* 11, as full as if it were distended with a pair of bellows.

EXPERIMENT V.

APRIL 28. Into the bottom of a widemouthed vial we put some good spirit of salt, and filings of steel, and whelmed over it a R^r. fitted with an eel-skin and a wire, to the latter end of which was tied a thin glass-vessel, hermetically sealed at the bottom, though it was but slender, and furnished with a competent quantity of filings of copper: then we exhausted the R^r. well with our engine, and afterwards thrusting the glass, that held the filings, against the bottom of the vial, we broke it off; upon which the filings fell into the menstruum, which acting upon them, there ensued good store of bubbles,

bubbles, that made a froth much deeper than was the liquor, and the successive generation of these bubbles continued a good while, and appeared some of them large enough, though in the free air they would scarce have been visible, or at least would not have been taken notice of; the vial having been kept in our vacuum for a quarter of an hour longer, and no greenness to be seen in the liquor, the R'. was taken off, and the vial left open to the air.

EXPERIMENT VI.

A BUBBLE of air, whose diameter was near in length to that of a middle sized pea, was left at the top of a round vial with a long narrow neck, whose cavity was filled with fine oil of turpentine, and then being inverted into a vial filled with the same liquor, was set aside in a quiet place, and left there for a competent time. Another vial shaped like the former, but a pretty deal less, was filled neck and all with alcohol of wine, save a bubble of air about the same bigness with the former: this vial being inverted into another furnished with the same liquor, was set aside in the same window with it, and at the same time: the event was, that about the end of the 6th day, the bubble disappeared in the glass, that contained the oil of turpentine. And the like absorption, if I may so call it, I observed to have been made of the air by the contiguous spirit of wine the next day after.

EXPERIMENT VII.

MAY the 23d. We opened another exhausted receiver, wherein was an unstopped vial more than half full of an opacous and blackish liquor, which we guessed (for we found no inscription belonging to it) to have been frog's spawn, and were sure to have been included at least three years: by the mercurial gage, that was put up with it, it appeared to have afforded some air, but not very much. Its smell was stinking, much like that of the pump of a ship, but yet it had produced no insects, nor had any appearance of mouldiness.

EXPERIMENT VIII.

A GENTLEMAN of my acquaintance, an industrious digger for mines, and owner of a good one, informs me, that when the miners meet with running water under ground, they are thereby supplied with air enough for free respiration: and when I asked, whether he thought, that air was produced or extricated by the motion of the water, or else were only concomitant to the stream? he answered, that it seemed to him more like to proceed from the water itself: and further answered me, that standing waters did not afford air to the diggers; and that running waters did it even at considerable depths, amounting to many fathoms.

Experiments about the Production of Air, and the examining thereof proposed.

SECTION I.

TO produce air by fermentation in exactly closed receivers.

To produce air by fermentation in sealed glasses.

To separate air from liquors by boiling.

To separate air from liquors by the engine.

To produce air by corrosion, especially with sp. aceti.

To separate air by animal and sulphureous solvents.

To

To obtain air in the exhausted receiver by burning glasses, and red hot irons.
To produce air out of gun-powder, and other nitrous bodies.

SECTION II.

EXAMINE the produced aerial substance by its preserving or reviving, 1st, Animals.
2dly, Flame. 3dly, Fire. 4thly, The light of rotten wood, fish.
To examine it by its elasticity, and the duration thereof.
As also by its weight.
AND by its lifting up the smoke of liquors.

T I T L E VII.

Of the accidental or less constant Ingredients of Air.

T I T L E VIII.

Of aqueous Particles in the Air, and of the Moisture and Driness of the Air.

I SHALL not here determine, whether in all the instances, that are referred to this title, the phænomena be produced by the mere moisture of the air as such, or by some other agents, whose corpuscles are accompanied and assisted by the moist air as a vehicle and a concurrent cause. But without nicely distinguishing the grounds of particular operations, we shall refer the phænomena in general to the moisture of the air, (or moist air) that quality being the most obvious to be observed in these phænomena; in the production of some of which it seems either the only, or the main cause, in others an assistant cause, and in all a not useless concomitant.

THE account, upon which a body is dry, being usually but this, that the pores intercepted between its more stable parts are not filled with any visible liquor, it is not to be expected, that a quality, so near of kin to a privation, should furnish much to our present historical notes: but yet driness may sometimes have a not inconsiderable interest in the changes of a body, and that upon differing scores, whereof I take these two to be the chief. First, as the body by exsiccation is deprived of those liquid and exhalable parts, that were before harboured in its pores, and were perhaps the principle of divers operations ascribed to it. And secondly, as these evaporable parts by their recess may occasion a change of texture in the body, especially in regard of the pores, whose bigness, figure, and perhaps position being altered, the body by this change of texture acquires a disposition to act, and be acted on in several cases, otherwise than formerly.

A transcript of
an observation
made at
Bianton.

SOMETIMES when the weather began to be overcast, the hygroscope did not sensibly appear to grow heavier; and sometimes it would preponderate, when I took notice of no vapours to make it do so: and though these things happened but seldom in respect of the ordinary changes of the hygroscope according to those of the weather; yet they made me suspect, that sometimes the clouds may consist of other steams than aqueous, or that there may be some exhalations, that may have a peculiar congruity with the pores of the hygroscope, and whose nature may be such, as to the power of drying the hygroscope, that upon these or some other yet unheeded accounts, the steams, that are sometimes diffused in the air, may controul the usual and regular

causes of increasfing or lessening the gravity of the hygroscope. And this suspicion was the stronger, because having made hygroscofes with powder and salt, and also with the saw-dust of wainscot, hung at nice scales in very thin open glasses, purposely blown for lightness sake at the flame of a lamp, though they usually acquired and lost weight, as the weather grew moister or drier, yet sometimes they did not.

EXPERIMENT I.

At half an hour after nine o'clock at night, I looked upon the half hundred weight, that hung at the bottom of the rope, the weather being then fair; and a mark being put at that part of the erected board, where the bottom of the weight touched, I perceived the sky a while after to grow cloudy and overcast, but without rain: wherefore going to visit the weight again, I found it to be risen $\frac{1}{4}$ of an inch or more; and looking on my watch, perceived there had passed an hour and a quarter since the mark was made.

THIS morning I came again to look upon the weight between eight and nine of the clock, and found it raised above the newly mentioned mark, made last night, about one inch (for it was about $\frac{2}{5}$ ths of an inch.) This day, the weather being fair and windy, the weight was fallen by ten at night about six inches beneath its station, at which I found it when I looked on it in the morning.

BEING not well yester-night, the weight was observed at bed-time by two of my servants, and it then rested at the 11th of the erected bound. This morning, about eight of the clock, I visited it myself, and found it to be risen about $\frac{7}{8}$ of an inch above the eighth inch, the morning being cloudy; though the morning very dry and dusty. The weather growing more overcast, within somewhat less than an hour after, I visited the weight again, some scattered drops of rain then beginning to fall, and found it to be risen about half an inch above the newly mentioned eighth mark.

I LOOKED, when I was ready to go to bed, upon the suspended weight of 56 pound, and marked how low it reached upon the divided board; and a great part of the night having been rainy, I looked again, when I was dressed in the morning, which was about half an hour after eight a clock, and I found the cord so shrunk, that the weight was raised above five inches higher than I left it the night before; but the day recovering dry and windy, and sometimes warm, the rope was so stretched, that at night the weight sunk a good way beneath all the marks. *N. B.* The rope near the weight was in diameter $\frac{3}{16}$ of an inch, and four decimal parts of a tenth.

EXPERIMENT II.

WE took a rope of near three foot and an half in length from the point of appension, and somewhat less than $\frac{3}{16}$ (inch) in diameter: this we suffered to be stretched for some days by a weight of lead with an iron ring or ansula, weighing a quarter of an hundred, according to the great hundred, which is five score and twelve: and then placing a flat board under it, so that the weight just rested upon it, we had the rope well wetted over them with a sponge dipped in water, and so often applied to it, that the liquor might be thoroughly soaked into the pores of the rope, which at first seemed thereby a little stretched, rather than shortened; but after an hour or two it began to shrink, so that we could make the weight swing like a pendulum over the piece of board it leaned upon before. But afterwards the same day the weight stretched out the rope again as much as formerly.

It is observable, that though *Morocco* be an inland-town, and the soil of those parts be usually dry, if not parched; yet doctor *D.* who was lately there, informed me, that

that about *Morocco*; notwithstanding the violent heats he felt in the day-time, he observed the nocturnal air to be very damp, so as to make the clothes he put off at night exceeding moist, and unfit to be worn, without airing the next morning. He added, that though the air was very piercing, and manifested itself to be so by many other signs, yet it would not make his knife rust in his pocket, or his sword in the scabbard, though it would quickly produce a rust in instruments of that metal exposed naked to it.

AIR too moist cannot be wholesom. The air in our parts, viz. about *Oakly* in *Buckinghamshire*, though a high country, is, as I said before, between *Michaelmas* and *Alballontide* very moist, especially in rainy weather, and upon a thaw, insomuch that wainscots, staircases and pictures will stand all of a water, and after run down in great drops; and at *Brill*, upon that high hill, it is in divers houses worse than in the valley, insomuch that the stair-cases, especially if laid in oil, will run down with water: the north and north-east side of our houses are observed to be moister, insomuch that the furniture will rot, if fires be not made sometimes in the rooms, and the things aired: this is observed to be the most aguish season of the year. Mr. J. T.

As in another experiment we tried, whether or no the removal of the air out of the receiver would much alter the temperature of the included medium or space, as to heat and cold; so we endeavoured to discover, whether the alteration would be notable, as to driness and moisture. To this purpose we did indeed wish for such a hygroscope (or instrument wherewith to measure the moisture and driness of the air) as we used, many years ago, and since found well described by the industrious *Kircher*, in a place of his *Ars Magnetica*, to which I therefore refer your lordship. But in regard that to this instrument there is requisite the beard of a wild oat seasonably gathered, which we could not then procure; we recalled to mind another hygroscope, which, though it discover not such small mutations as the former, we thought might be usefully enough substituted instead of it.

Of this hygroscope, having particularly described it in another paper, we shall now only say in a word, that it is made by fastning to the upper end of a piece of gut-string, or great lute-string, a very light index, and strongly fastening the lower end of the same string to the bottom of a box, or other convenient frame, the circumference of whose upper part may be at pleasure divided into degrees or other partitions, upon which the index may move to and fro. For the instrument being thus made, when the air grows moister, the vapours insinuating themselves into the pores of the filaments, that compose the string, do somewhat shorten it; and thereby those filaments being altered in point of contortion, the index that is fastened to them turns one way; and, upon the recess of those vapours, or of others of like nature, the string comes to be wreathed, and consequently the index to be moved another way. So that, in a string of about three inches long, the point of the index will be oftentimes made to change its place very notably, by such a mutation of the air, as to driness and moisture, as was to be met with in the morning and at noon of the same day, though such a change did not always need either rain, clouds or mists, or the absence of them, to make it notable.

EXPERIMENT III.

WE took then one of these hygrosopes, and conveyed it into a small receiver, that the removal of the air being sudden, the change of temperature (if any should happen) in the exhausted cavity, might be the more sudden and conspicuous. But we found

found not that the emptying of the receiver made the index sensibly change place. And though this experiment were carefully made, yet for the greater security we repeated it once more; and neither then perceiving the index to remove, we kept the receiver exhausted for a pretty while, lest there should be some more time requisite to the operation of the medium upon the instrument. But neither did this trial produce any sensible alteration of the index; but after the key was turned, and access was thereby given to the excluded air, though the cover were still kept on, we found, that then within some hours, the index was considerably removed. So that as far as these experiments informed us, the ether or subtil matter, that succeeds in the place deserted by the air, if that place be not left void, and consequently the thinner and more fluid part of the atmosphere (in which the corpuscles, that may be more properly called aerial, swim) seems in its own nature to be very sensibly, neither cold, or hot, or dry, or moist. I said, as far as these experiments; I mean those we made in this engine with the thermoscope and hygroscope, inform us; because this conjecture (for I dare yet call it no more) may be examined divers other ways, whose events may either confirm, or oppose, or limit it. In the mean time I could wish, that if your lordship had one of *Kircher's* hygrosopes at hand, you would frequently and carefully try the last recited experiment with it; because I have found, that if such a hygroscope be very well made, it is admirable, as well as pleasant, to see how small a mutation of the neighbouring air it will take notice of. But I thought fit to desire to have it frequently tried, because care must be taken, that such motions of the index be not mistaken for the effects of the altered temper of the medium in the receiver, which may in some cases proceed from those steams of the oil and water, which we elsewhere mention, that we now and then, though but seldom, observed to get out of the cylinder into the receiver, and play up and down there.

T I T L E IX.

Of Clouds, Mists and Fogs.

HEARING that an excellent astronomer of my acquaintance had often measured the height of clouds, I enquired of him what height he observed them to have? and was answered, that though he had measured eighteen or twenty even of white clouds in fair weather, yet he observed scarce any one to be higher than three quarters of a mile, and few of them he found to exceed half a mile.

A MIST coming, driving upon the sea towards the shore, though without any sensible wind, will rise a greater swell of a sea, than a brisk wind will do. *N.*

I HAVE observed in a ground near my house, which is somewhat moist in winter, as also in other places, especially after a warm day, and against fair weather in autumn, a moist bluish mist to ascend about twenty or thirty foot high, and then to subside again in dew. *Mr. J. T.*

T I T L E X.

Of terrestrial Steams in the Air.

ENquiring of an ingenious acquaintance of mine, who, in an inclosed scope of ground, has several veins of differing metals and minerals, whether he did not see, and sometimes smell steams ascending out of this or that spot of his ground, in

circumstances where their ascension could not be imputed to the action of the sun? he and his son, who was also a virtuoso, told me, that they had divers times seen as it were pillars of fumes ascending like smoke, whereof some would be inodorous, some ill-scented, and some, though but seldom, well-scented. And you may have observed, as well as I, that fogs, some of which I have known to be very lasting, and to have a large spread, did require no tender nostrils to perceive them to stink.

I HAVE frequently observed the smoking steams, that arose out of the shafts of mines not wrought in: and it is certain, the charcoal made in *Cornwall* (especially of that wood, that grows in the mineral part thereof) doth afford a manifest arsenical and sulphureous smell beyond other charcoal. N.

*Journal
des Sca-
vans III.
1685.*

Tel est par exemple ce nuage horrible d'une fumée épaisse, qui s'éleva de la mer de Crete au commencement de l'este de l'an 721. Et qui s'étant repandu dans l'air le fit paroître tout en feu. La mer n'en fut pas mesme exempte; car les grosses masses de pierres enflammées qu'on en vit sortir, Et qui se joignirent à l'isle qu'on nomme Hiera, échaufferent si fort les eaux, qu'elles en bruloient les mains.

T I T L E XI.

Of Salts in the Air.

IT is sufficiently known, that the peripatetick schools teach the air to be an element warm and moist; and if it be an element, it ought, according to their principles, and those of the greatest part of other naturalists, to be a simple and homogeneous body. But because such an elementary or uniform purity is much easier to be found in the writings of schoolmen, than amongst the works of nature, many of the modern philosophers have justly forsaken this doctrine of the elementary simplicity of the air in some measure; but perhaps very few of them, if any, have asserted the air to be so exceedingly compounded a body, as in my opinion it really is. For divers of them grant indeed, that the atmosphere is not absolutely pure, but yet think, that it differs but gradually from true and simple air, as water a little moved and troubled does from clear and settled water. But for my part, I confess I acquiesce not in either of those notions of the air. For, as I have elsewhere more fully declared in a short discourse, purposely treating of the substance of the air, although I will not deny, that there is an ethereal matter more subtile than the common air, which ether I take to be diffused through all the interstellar part of the universe known to us, reaching to and surrounding all its great globules; yet, speaking of the air, which we men live and breath in, I take our atmosphere to consist not only of the purer ether, but in great part of a vast multitude of effluvia emitted by the terraqueous globe, and the various bodies it is made up of, and perhaps in some parts also of substantial emanations from the celestial bodies; and that that, whereby the atmosphere differs from such pure air, as the schools tell us of, is not a bare and indeterminate feculency, but a confused aggregate of several distinct and perhaps disagreeing kinds of effluvia. And amongst those, one of the principal sorts I take to be the saline ones, which rove up and down amongst others in that vast ocean of effluxions, we call the atmosphere: wherein yet I do not think there are to be met with, either all sorts of them every where, or perhaps any sort in like plenty, in all places, and at all seasons.

To shew, that the air is not unfurnished with parts of a saline nature, I might alledge some considerations, that seem to make it probable *à priori*, as they speak, that there are always some such corpuscles emitted into the air. But, instead of insisting on
such

such particulars, because they may seem too little of an historical nature, to be fit for this paper, I shall content myself to take notice in the general, that almost (if not more than almost) all the arguments I have employed, to prove the copious ascension of subterranean steams into the air, may be applied to our present purpose, since, amongst the effluviating substances of the terraqueous globe, there are, as I have declared in another paper, huge quantities of common or marine salt, besides nitrous, aluminous, vitriolate, and perhaps other kinds of salts. To which I shall add, that the emission of subterranean aporrheas or effluxes, is not the only means, whereby the air may be impregnated with saline particles; since the exhalations and vapours produced by the action of the sun-beams upon the more superficial parts of the earth and sea may supply the air with swarms of corpuscles, as well of saline, as of any other nature. Not to mention, that the number of these may, in divers places, be much increased by those vulcanos, that have opened vents to discharge their fumes into the air; by those numerous fires, which, burning in our chimnies, produce much saline smoak; and by other ways, which I shall here forbear to discourse of, for the reason lately given for my declining arguments drawn *à priori*; though some things applicable to this purpose will in likelihood occur amongst the instances I am about to add, to make it seem probable *à posteriori*, or by some effects and phænomena, that the air is impregnated with saline corpuscles, that are none of its least active parts, and may have great interest in divers of its operations.

FROM what has been hitherto delivered, to make it probable, that there is a saline substance in the air, I thought fit to proceed to other inquiries. The first; whether the aerial salts be of differing kind? and if so, which they are? and the second, how it comes by its saline substance? But about such differing points I durst promise myself but little satisfaction, and therefore shall not pretend to give you much.

AND yet, to say something to the first of the two enquiries, I am prone to think, that the saline particles of the atmosphere are not all of one sort, but that there may be three or four differing kinds of aerial salts.

I KNOW, that divers learned men, some physicians, some chemists, and some also philosophers, speak much of a volatile nitre, that abounds in the air, as if that were the only salt wherewith it is impregnated. But though I agree with them, in thinking, that the air is in many places impregnated with corpuscles of a nitrous nature; yet I confess I have not been hitherto convinced of all that is wont to be delivered about the plenty and quality of the nitre in the air: for I have not found, that those, that build so much upon this volatile nitre, have made out by any competent experiment, that there is such a volatile nitre abounding in the air. For having often dealt with salt-petre in the fire, I do not find it easy to be raised by a gentle heat; and when by a stronger fire we distil it in close vessels, it is plain, that what the chemists call spirit of nitre, has quite differing properties from crude nitre, and from those that are ascribed to the volatile nitre of the air; these spirits being so far from being refreshing to the nature of animals, that they are exceeding corrosive: And even when I caused earth to be dug up in an old pigeon-house, because that is accounted the most nitrous sort of earth, and distilled it with moderate fires, I did not find the volatile saline parts, that came over, to be like that, which these learned men conceive the air to be stored with. Nor have I met with among them any positive proof, to evince the truth of their opinion; which yet, as I was saying, I am content to admit, as an ingenious supposition, until something be offered, that shall prove it to be more; which I think not impossible to happen, at least as to some times and places. But I am not yet sure, that the exhalations, that ascend from the subterranean parts, and perhaps also the sun-beams themselves, may volatilize many of the

nitrous corpuscles they chance to act upon, and elevate them into the air, without analyzing them, or destroying their texture, as our fires are wont to do. But however, I do not take the hitherto mentioned nitre to be the only salt, that impregnates the air: for when I consider, how vast a portion of the terraqueous globe is covered with the salt sea, and how vast quantities of fossile salt, as well fine and clear, as coarse, are dug up in *Poland*, especially near *Cracovia*, in *Hungary*, *Transylvania*, and in divers other parts of the earth; when I consider too, that we seldom find salt-petre in the earth, but that there is sea-salt mixed with it, which puts the salt-petre-men to a great deal of trouble to separate it; and that even from salt-petre, that passes for good, I had trouble enough, when I had the curiosity purposely to refine it, to free the purely nitrous from the other saline particles; I am prone to suspect, that in very many places, especially maritime ones, the effluvia of common salt do, at least as plentifully as those of salt-petre, abound in, or impregnate the air: which conjecture might be favoured by divers things, if I had leisure to insist on them.

THAT in some places, that abound with marchasites, there is a kind of fretting vitriolate salt, copiously dispersed through the air, I have been inclined to think, partly by other inducements, and partly by the answers made me by a very observing man, who lived in a place, that I remember I visited; where being forced to reside a good while, he found the hangings of his chamber, and the curtains of his bed, rotted by the vitriolate steams expired by the soil, whose effluvia had also very manifest and unwelcome effects on divers other things, that were kept near that place; though on the opposite side of the river, in a town, that is not half a mile distant from this place, neither I, at my being there, heard any such thing complained of, nor the relator, who had often occasion to repair thither, observed any such mischievous effects, the soil of this latter place being chalky; whereas the other above mentioned is vitriolate, insomuch that he observed, that when the moist and blackish mould had been beaten upon by the sun, that here and there the superficial parts would be as it were besprinkled with a somewhat whitish saline efflorescence.

BESIDES the hitherto-mentioned kinds of salts, it seems not improbable to me, that the air (especially about great towns, and some other particular places) may be impregnated with volatile salts, that are of a nature contrary to acids. For that there may be places in the earth, even at a good depth under ground, that lodge such salts, I have been induced to think by the experience of an acquaintance of mine; who, hoping to find in the salt of what he supposed to be virgin-earth, the true receptacle of an universal spirit, from which he promised himself great and profitable matters, caused to be dug up a great deal of a certain clay, in a place abounding with minerals, and obtaining thence, by mere distillation, no inconsiderable quantities of spirit and salt, which in divers qualities, as smell, &c. I judged to be near a kin to the spirit of urine or hartshorn. And yet this earth was dug up at the depth of many feet, not to say yards, beneath the surface of the ground (as an ingenious potter, from whom the chemist had the clay, assured me upon the place itself) which I once visited, to see some other choice minerals, that ennobled that soil; whence I would have got a quantity of the abovementioned clay, but that it being then the midst of winter, the rain had (as the workmen speak) drowned the pit.

In great cities, and also towns, where much wood is burnt, it is probable, that numerous particles of volatile salt may be dispersed through the neighbouring air. For, as I have elsewhere shewn, the foot of burned wood, which is but that small part of the smoke which chanches in its passage upwards to stick to the chimney, does very much abound in a volatile saline spirit, which by many trials are found to have

so much affinity to that of urine and of hartshorn, as not to be easily, but by the smell distinguished from it.

BESIDES in several places the putrefaction of substances, that once were parts of animal bodies, may furnish the air with volatile salts, as I have elsewhere mentioned, that I found, that urine, without distillation, will by bare putrefaction afford saline and spirituous parts, that whilst they yet swim in the copious phlegm, that makes up the body of the liquor, will manifestly discover themselves to be volatile, not only by their smell, but by their hissing with acid spirits, and by their dissolving some bodies, and precipitating others, according to the manner of volatile sulphureous salts, as those that abound in spirit of hartshorn, blood, &c. And I am apt to think, that it is not only in the parts of animals, but also in those of many vegetables, that putrefaction may either extricate or produce volatile salts. And I remember, I have observed in some succulent vegetables, that chancing to lie in a heap together, in a convenient season of the year, to make them rot; I observed, I say, when the putrefaction was come to a certain point, that the stink did so resemble that of carrion, that it was not easy for me to believe it came from cadaverous plants, not animals. And that it is not impossible for a vegetable to afford, without the help of an additament, a volatile salt, even *in forma sicca*, may be gathered from what I elsewhere relate, of my having distilled such a salt from a certain spiritous seed, though, I freely confess, I never obtained any (without previous incineration) from above two or three vegetables. But of this enough in this place.

I SHALL now add, that besides the more simple salts hitherto enumerated, it is not unlikely, that in some places the air may sometimes contain compounded salts. For I have elsewhere shewn, that some sorts of saline spirits, meeting one another in the air, may there convene. And I elsewhere teach how to order a couple of liquors so, that one will never of itself afford any thing in a dry form; and yet the spirituous effluvia of this liquor, meeting with those of the other, will exhibit a volatile and saline body in a dry form; though the liquors themselves being mingled will not afford any such substance. What I have elsewhere delivered concerning subterranean steams, may make it probable, that at least now and then, and in some places, there may be sent up from under ground into the air, among other effluvia, store of saline ones, which needs not be supposed all of them to be of an uncompounded nature. With which that agrees very well, that was related to me by a very intelligent acquaintance of mine, that lived long in parts of *America*, where there was a vulcano, which he and some others having the curiosity to visit, told me, that before they came any thing near the fire, or were offended by the heat, not only the skin of his face was almost corroded by the sharpness of the exhalations, but the colour of his hair was altered by it, which kept him from prosecuting his intended discovery. It is a known thing, and I have received information of it from more than one eye-witness, that about mount *Vesuvius*, the ascending exhalations, that issue out at some of the holes, are of so saline and sulphureous a nature, that part of them stick about the orifices of those vents, in the form of flower of brimstone, of which a learned acquaintance of mine brought away some quantity. And I have had brought me from some of those vulcanos a stone, whose cavities abounded with a white salt, which, by fit trials purposely made, was found near a-kin to sal-armoniac, and easily resolvable into a salt, whereof one part was somewhat fixed, and the other very volatile; which made it highly probable, that the salt was compounded in the bowels of the vulcano: whence I have been credibly informed, that great quantities of it have been cast up in the fiery eruptions, and therefore store of it might in likelihood be dispersed through the air, since I found the salt itself to be sublimable.

But, besides the saline substances hitherto mentioned, which may be referred to determinate species, I think it not impossible, that the air may, at least in some times and places, be impregnated with corpuscles of a saline nature, whether simple, or compounded, or of both kinds, not easily reducible to any of the sorts we have been speaking of, or are acquainted with. For which reason I shall not presume to give them any other denomination, than that indefinite one of anonymous. And I have been inclined to think, there may be such bodies in the air by these two inducements. The first, that the particular aerial salts, that have been hitherto recited, are but few, as it seems probable by what I have said in other papers of subterranean steams and menstruums; and that therefore there may ascend out of the earth into the air saline fumes, differing enough from those, whose kinds we have hitherto described. But besides this consideration *à priori*, (as they speak) experience has presented us with some phænomena, that seem *à posteriori* to confirm this conjecture. For there happen such changes to some bodies, by being exposed to the air, as though I am not sure, and therefore shall not be confident, that they are mainly produced by some nameless substance of a saline nature, may yet make it allowable to suspect them to proceed thence. And amongst these I shall take leave to insert some, which I deny not to be probably referrible, either to one or other of the formerly enumerated kinds of aerial saltiness. For laying these instances before you together, they may, by appearing thus associated, give the stronger probability to our opinion, that there are saline substances in the air. And those instances, that are not so proper to persuade you, that there are anonymous salts, may serve to confirm, that there are, at least in divers places, differing sorts of aerial salts. I remember I have more than once visited old glass-windows, in high and ancient buildings, and found some of the panes of glass here and there corroded, as if they had been worm-eaten; which probably enough argued the sharp and fretting corpuscles to have been carried along with the winds, to which they were exposed, as will not easily be reduced to any formerly named salts, whose being unable to corrode glass, especially no finer than that was I speak of, is sufficiently known to chemists.

BESIDES the above-mentioned phænomena, others have occurred to me, which possibly it would not be thought impertinent to subjoin on this occasion; but I choose rather to reserve them for another discourse; and now should put an end to this, but that I dare not conceal from you, that I sometimes had thoughts of trying, whether a discovery may not be made, what kind of saltiness there is to be found in the air, and whether the aerial saltiness does or does not abound there, at least at this or that time. But this I freely confess to be so difficult an attempt, that all that I can offer pretends but to dissuade you from rejecting it, as too desperate and extravagant a thing to be fit to be tried.

AND I speak the less promisingly of what I am to say in the remaining part of this paper, because I have not by me any notes to assist my memory, (which I dare not trust alone) concerning the issues of the not numerous trials, I had opportunity to attempt in pursuance of those thoughts. This I well remember, that among other ways of making the intended aerial discoveries, I looked upon this as the least unpromising, that such subjects should be carefully chosen out, as being disposed to be differently wrought upon, according to the differing sorts of saltiness, that may be found predominant in the air.

THIS more general way of investigating the salts of the air may contain divers particular methods, of which I shall now touch upon the following three.

FIRST, it may be worth while to expose to the air such bodies, as we judge fittest to be wrought upon by the salt, that we think likeliest to be met with in it. So where

we guess the air to be impregnated with nitre, we may expose lime to it, or some other body, that we think disposed to imbibe or retain such a saltiness. We may also hang up in such an air clothes or silks died with such colours, that nitrous (for instance) or salinosulphureous spirits (as some chemists call them) have been found peculiarly apt to make to fade, or to discolour them. In the places where we suspect vitriolate steams to abound, some appropriated preparations of sulphur, either common or metalline, may be exposed, to try, whether they will acquire a blackness, as I have several times found some of those sulphurs, though otherwise of no dark colour, to do upon the least contact of vitriolate corpuscles. In some places also, which are judged likely to afford subterranean steams, guesses may be made, whether this or that kind of salt ascends into the air, by spreading upon the ground, in places free from dirt and dusts, large pieces of clean and white linen cloth, that has no relish of soap or lees; and observing, after they have lain a competent while, whether, and how they are discoloured, and what kind of saltiness, if any, is to be found in the moisture imbibed by them, from the ascending steams and falling dew.

THE NEXT of the above-mentioned ways of enquiring after the saltiness of the air may be, to find, if it be possible, some one body, that is both capable to be wrought on by several aerial salts, and will be so differently wrought on by them, as to discover which kind of salt it is, that has produced the change. That it is very difficult to find such a body, I will readily grant; but that it may be possible, I will not be forward to deny. For having pitched upon copper to make this trial with, though the attempt did not succeed according to my wish, yet perhaps it was chiefly for want of time and accommodations that it miscarried. For having taken plates of copper beaten thin, (without regarding their bigness, or figure, or smoothness, as things not necessary to my purpose) I caused the surfaces to be made very clean, that the colours might be the more easily produced, and the better discerned: then keeping these over glasses, wherein were placed divers spirits, as of common salt, and of nitre, partly sincere, and partly diluted with water, I observed, as I expected, that though I put the glasses in no heat, yet there ascended fretting particles out of the liquors, and that within less than a day, the steams of the two above-mentioned liquors had much darkened the surfaces of the copper plates they met with in their way, the keeping them a while in the air was not hard to know by the differing discolorations that appeared, which plate had been invaded by the saline corpuscles, and which by the nitrous; which I did not at all wonder at, because I have formerly found, as I have elsewhere noted, that whereas spirit of nitre will make of copper a greenish blue solution, spirit of salt will, if duly employed, dissolve that metal into a grass-green liquor, as the spirit of foot and that of urine will into a deep blue, almost like ultramarine. But, as I said, the want of time, of which good store may be requisite for such trials, kept me from prosecuting my attempt to an issue. Notwithstanding which I look not upon the design as desperate, not only because of the encouragement I have already mentioned to resume it; but because I have observed pieces of malleable copper, brought me, to examine, out of an English mine, (which is yet concealed) to be overcast here and there with a fair verdegrease, which by circumstances I judged to have been produced, not by gross liquors, but by the air impregnated with steams fit to work on that metal. And possibly there may be other subterranean bodies, and even metalline ones, that by their degree of colour, or peculiar kind of rust or stain, that they will acquire in the air, may help us to guess what substances, and among others what salts the air of that place is impregnated with. I have been in a great and stately house, which being oddly seated, had this peculiar inconvenience, upon the score of the steams that infested the air, that those that dwelt in it;

Experiment E.

as one of the chief of themselves complained to me, could not keep their silver plate, of which they had great store, from being blemished by odd discolorations, or, as they seemed to think it, rust; though when it was not used, they carefully kept it in a place judged convenient for such a purpose. And I have been informed by an observing man, who lived there some time, that there is nothing more generally known in *Amsterdam*, than that their silver plate there, exposed a little while to the common air, tarnishes immediately, contracting a dirty colour, partaking of yellow and black. Another instance or two, though not afforded by plate, I could mention to the same purpose; but I reserve them for another place, my haste obliging me to pass on to the last of the three ways I proposed of investigating the differences of aerial salts.

THE third way may be looked upon, if you please, as a variation of the second; but there is this difference betwixt them, that here we make use of metalline bodies, not crude, but already prepared by some chemical operations; so that being before hand reduced to very small parts by the intervention of saline substances, the operation of the air upon them is wont to be much the sooner performed. In this third way then we employ such fictitious minerals or other bodies, as having for the most part an adventitious colour already, will change that colour by being exposed to the air. For it seems not impossible, but that by diligently observing, what difference may be found in the discolorations produced in these substances by the differing kinds of salts, as nitrous, salinofulphureous, &c. that we have shewn may be met with in the air, some guesses may be made in a short time of this or that salt, which has the chief stroke in the production of the exhibited colour. And I shall on this occasion mention two or three bodies, without determining, till I be better satisfied, whether their changes proceed only or chiefly from the salt of the air; but I am content not to pretermitt them, because if they do not prove what I propose, they will at least clear the meaning of it, and may however help us to guess at the resemblance or difference of airs in several places, by the likeness or unlikeness of the produced changes of colour, whether these changes proceed from saline, or from any other substance intermingled with the air.

Experi-
ment II.

IF we precipitate a strong solution of good silver made in aqua fortis, with a competent quantity of spirit of sea-salt, we shall have a powder, which at first will be very white; but if the liquor be not poured off, this being exposed for a good while to the air, it would acquire on the surface a dark colour, which perhaps an attentive eye will discern somewhat various, as this or that kind of saltiness happens to be predominant in the air.

Experi-
ment III.

WE took an equal weight of good filings of copper, and powdered sal-armoniac, which being well mixed, were put into a covered crucible, and kept in a moderate fire over ignited coals, till the sal-armoniac had either quite or almost done smoking: then as much of the remaining mass as could be parted, was taken out, and looked of a dark colour; but this mass being grossly beaten, and exposed for some time to the air, looked like a kind of verdegrease, which is a substance, whose colour may be observed somewhat to vary, according to the nature of the particular salts, which by working on, and embodying with the copper, produce the pigment. But a parcel of the same mass being, before the air had time to work much upon it, grossly powdered, and hermetically sealed in a glass egg, to fence it from the air, and left in a south window, did not appear discoloured, when the out-side of the other parcel shewed like verdegrease: which seems to argue the change of colour to have been made by the aerial salt, if we suppose the moisture of the air to have had no interest in the change, or to have concurred to it, but as a kind of vehicle assistant to the salt.

I ALSO took spirit of the foot of wood, and having poured a little of it on the filings of copper, my expectations were answered by my finding, that the liquor dissolved some parts of the metal into a deep and lovely azure like ultramarine; and that this solution being suffered to grow dry in an open glass, by the mere operation of the air, the ceruleous colour very soon degenerated, even before the matter was quite dry, into a cyanious colour, such as may be seen in good turquoises. And to manifest, that this change proceeded not from any peculiarity in the spirit of foot, and that this spirit acted as abounding with a salino-sulphureous salt; I shall add, that I had the success in a trial made with an urinous spirit drawn from animal substances, and put upon crude filings of copper. And in those trials I sometimes observed the differences of colours, that did not discourage me from hoping, that the prosecution of them might not be insignificant to my purpose.

Experiment IV.

I HAVE not been solicitous to describe the fore-mentioned changes of colours more particularly, because it had been very difficult to do so, and therefore I judged it more expedient not to attempt it. For there is so great a variety of colours, that few but painters can exactly enumerate and distinguish them by proper names. And yet, besides those more noted ones, there are many others, for which, though our language, nor perhaps any other, is not copious enough to furnish us with distinct appellations, yet our eyes, especially when they have been attentively conversant with such objects, are sharp enough to discern them: and by the help of these nameless (as well as the stated) colours, I am apt to think a heedful observer may perceive divers variations in the colours of the bodies we have been speaking of, that may assist him to guess, what substance it is in the air, whereto these diversities may be ascribed. And as nature is much more rich in things, than our dictionaries are in words, so has she furnished men with sensories capable of distinctly perceiving a far greater variety of objects, than they are able verbally to express. And this might be shewn by instances, in the organs and objects of senses less acute than sight, whose subtilty in distinguishing things I could exemplify, not only by what is related, but by what has been performed by some persons not unknown to me, particularly our famous Doctor *Harvey*. But examples of this kind I have not leisure to stay on; and therefore, without spending more words upon this third way of discovering aerial salts, I shall barely recommend the care of such observations to their curiosity, who shall think it worth while to make them.

WITH how little confidence of success, trials, that have the aims of those I have been speaking of, are to be attempted, not only consideration, but experience, hath made me sensible. But yet I would not discourage human curiosity from adventuring, even upon slight probabilities, where the nobleness of the subjects and scope may make even small attainments very desirable. Those adventurous navigators, that have made voyages for discovery in unknown seas, when they first discerned something of obscure near the horizon, at a great distance off, have often doubted, whether what they had so imperfect a sight of, were a cloud, or an island, or a mountain: but though usually it were more likely to be the former, (as that which more frequently occurred than the latter) yet they judged it advisable to steer towards it, till they had attained a clearer prospect of it: for if it were a deluding meteor, they would not however sustain such a loss in that of no great labour, as, in case it were a country, they would in the loss of what might prove a noble and rich discovery. And if they desisted too soon from their curiosity, they could not rationally satisfy themselves, whether they sighted a cloud, or neglected a country.

I do not perceive, that the air of our inland parts is considerably impregnated with esurine salt; since I do not find the bars and casements of our windows much im-

paired by rust after near eighty years standing, or that they are more rusty towards one quarter than another; though the air hereabout, (*viz.* Oakly in *Buckinghamshire*) is very damp about the end of autumn, and beginning of winter. So that I conceive this salt either proceeds from the sea-vapours near the sea-coasts, or else from the dissolution of this esurine salt in the air, upon the burning of sea or other mineral coles. Mr. J. T.

*Agricola
de re me-
tallica,
lib. duodec.*

Mox ollam ex igni remouent; postea ex refrigerata eximunt halinitrum purissimum: quod candidi marmoris speciem gerit; atque tunc etiam id, quod terrenum est, in fundo residet. At terra, ex qua dilutum fuit factum, & rami quernei vel consimilis arboris alternis sub dio ponantur, & aqua quæ combibit halinitrum conspergantur: quò modo quinque vel sex annis rursus apta fit ad conficiendum dilutum. Halinitrum quodammodo purum, quod dum terra tot annos quieuit interea, ortum fuit, & quod lapidei parietes in cellis vinariis & locis opacis exudant, cum primo diluto permistum decoquatur.

Si verò locus aliquis talium venarum copiam suppeditauerit, ipsæ statim non conijciuntur in castella; sed primo conuehantur in areas, atque cumulentur: quanto enim diutius aeri & pluuiis expositæ fuerint, tanto meliores fiunt. Nam in ejusmodi cumulis, aliquot post mensibus, quam venæ in areas fuerunt congestæ, nascuntur fibræ longe venis bonitate præstantes: deinde uehantur in sex, pluravæ castella, longa & lata ad novem pedes, ad quinque alta.

Si verò dum dilutum recoquitur, separata non fuerint, mox ex minoribus vasis infundatur in majora, eaque concludantur: in quibus item atramentum sutorium separatim ab alumine concrescit: utrumque excisum, & in hypocausto siccatum diuendatur dilutum, quod in vasis & cupis non concrevit in cortinam refusum recoquatur: sed terra, quæ in fundo cujusque cortinæ refedit, ablata in castello unâ cum venis, denuo aqua & urina diluatur. At terra, quæ in castellis diluto, postquam effluxit, supersuit egesta & coacervata quotidie, rursus magis ac magis fit aluminosa, non aliter atque terra, ex quâ halinitrum fuit confectum, suo succo plenior fit: quare denuo in castella conijcitur, & aquæ affusæ ea percolantur.

A LEARNED observer, who practised physick in one of the most southern of the English colonies, being asked by me about the effects of the air there upon iron, affirmed to me, that the great guns there are so subject to become rusty, that, after they have lain a very few years in the air, one may with a hammer knock off whole scales, or rather cakes, of crocus martis: and he observed, that those guns, that lay only exposed to the air, did this much more than those, that by accidents were drowned, and lay covered with the salt water.

AND since dew is made of steams of the terrestrial globe, which whilst they retain that form, and were not yet conuened into drops, did swim to and fro in the air, and made part of it; the phaenomena, that shew the power of dew in working on solid bodies, may help to manifest, how copiously the air may be impregnated with subtil saline parts. Wherefore I shall here add, that having met with a person, that was bred as well a scholar as a traveller, and had visited not only some of the maritime places of *Brasil*, but some of the inward parts of that vast country, I enquired of him about the subtilty of *Brasilian* dew, and its power to rust metals: about which he told me, that it was certainly very great, and would not only rust knives and such instruments, but likewise money, which he assured me he had particularly observed; adding, that in several places the Portuguese kept their great guns cased over, that the dew might not fall upon them, and by its corrosiveness so rust them, as to be apt, after a while, to break in the discharge. And when I demanded whether he tasted the dew, to observe the saltness of it? he replied, that he had not, but that he had in divers places observed, that it left the grass, &c. that it had rested on, covered over with a pure white salt, as if it had been a hoar frost.

AN ingenious traveller, and student of physick, being discoursed with by me about some particularities of his country (which is *Swedeland*) relating to minerals, and their effects upon the air, assured me, that in a city, or notable town called *Fablun*, which is built on the lower part of an hill, containing one of the best copper mines in *Sweden*, the exhalations, that are copiously emitted by the latent minerals, do so affect the air in and about the place, that their silver coins are oftentimes notably discoloured by them, not seldom made even black or blackish, though the money be kept well tied up in bags or purses, and these perhaps placed one within another, and the whole aggregate be kept locked up in coffers or presses made of wood of perhaps an inch thick: he added, that these subterranean steams have manifest effects upon brass, (wherewith that country abounds) insomuch that there being kept in the principal church seven crowns made of that metal upon a particular occasion, the sulphureous steams made those, that looked to them, take the pains to cleanse and brighten them at a month's end, till finding, that the labour was every month to begin again, they at length grew weary of it, and suffered these crowns to grow, as they yet continue, as black (to use his own phrase) as the tunnel of a chimney: this he averred to be true, as having a good opportunity to be sure of it, in regard of his being a native of this town. And he further assured me, that the corrosive exhalations did so penetrate the bars and vessels of iron, that lye exposed to the air, that, after a while, it is easy with a hammer to knock off scales of Mars, which are friable into a powder, like crocus, save that the colour is more dark.

T I T L E XII.

Of Sulphur, and inflammable Particles in the Air; and of Lightening, and its Effect.

YESTERDAY a Neapolitan lord, a person of high quality, and very curious, being asked by me some questions about some natural phaenomena relating to *Vesuvius* and the adjacent country, assured me, that, having had occasion to stay for divers months at a country house but little distant from *Naples*, he took much pleasure, taking the air on horseback upon a very sulphureous soil, to take notice of divers observables to be met with there; and that he often found, that, when his horse trod something hard upon the ground, there would be produced a great (and as it were a crackling) noise, which would have frightened a stranger; and that oftentimes he could discern, that, where his horse had trod, there would presently arise a dust, and fumes that were manifestly sulphureous and ready to take fire: adding, that sometimes he thought that they actually did so. He further told me, that he sometimes, for curiosity sake, caused some clods, or as it were turfs, to be cut out of that soil, and laid in a kind of heap; and that then in the night he could observe, that the steams, that plentifully issued thence, would sometimes be kindled by or in the air, as they ascended in it.

THE same nobleman told me, that, when some years ago there were eruptions of fire in mount *Vesuvius*, he and others observed, with amazement and horror, that the flame, which shot up into the air, from the *Volcano*, was of so prodigious a height, as invited them to measure it with a quadrant, by which they found it to be near two miles high: and when I asked, if he comprised in that height the altitude of the mountain itself? he answered, that he did not; for the flame, that appeared above the top of the mountain, appeared as high as the mountain itself; and it

was from the top of the hill, and not the bottom, that they computed the height of the flame. He added, that sometimes the earth would tremble, and there would be discharges of such vast stones, and other heavy things, that he saw some masses of ignited matter thrown up a great way into the air, that were bigger than the chamber he did me the honour to visit me in, though that were a large room for a bed-chamber.

*Voyage de
Levant,
p. 203.*

*Accident
extraordi-
naire à
Santorini.*

Voila tout ce qu'on peut dire de cette isle, qui semble un enfer, car on voit la mer du port, & de la coste toute noire & brûlée d'un petit esueil, qui paroist depuis environ soixante ans, & d'où on vit sortir en ce temps là une grande flamme, qui y a laissé une ouverture si profonde, que si on y jette une pierre, on ne l'entend point tomber. Mais ce qui est arrive depuis en ce port, n'est pas moins estonnant: je le rapporteray icy comme je l'ay appris de diverses personnes en plusieurs endroits. Il y a environ 18 ans, que durant la nuit d'un certain dimanche, commença dans le port de Santorini un tres grand bruit, lequel s'entendit jusques à Chio, qui en est éloigné de plus de deux cent milles, mais de telle sorte, qu'on crut à Chio, que c'estoit l'armée Venitienne, qui combattoit contre celle des Turcs, ce qui fit que dès le matin chacun monta aux lieux les plus élevez pour en estre spectateur, & me souviens que le reverend pere Bernard superieur des Capucins de Chio, homme venerable, & tres digne de foy, me conta, qu'il y avoit este trompé comme les autres, car il crut aussi bien qu'eux entendre plusieurs coups de canon; cependant ils ne virent rien, & en effet ce fut un feu, qui se prit dans la terre du fond du port de Santorini, & y fit un tel effet, que depuis le matin jusqu'au soir il sortit du fond de la mer quantite de pierres de ponce, qui montoient en haut avec tant de roideur & tant de bruit, qu'on eust dit, que ce fussent autant de coups de canon, & cela infecta tellement l'air, que dans la dite isle de Santorini, il mourut quantité de personnes, & plusieurs de la mesme isle en perdirent la veue, qu'ils recouvrerent pourtant quelques jours apres. Cette infection s'estendit aussi loin, que le bruit qui l'avoit precede, car non seulement dans cette isle, mais mesme a Chio, & à Smyrne, tout l'argent devint rouge, soit qu'il fut dans les coffres, ou dans les poches; & nos religieux demeurans en ces lieux là me dirent que tous leurs calices en estoient devenus rouges. Au bout de quelques jours cette infection se dissipa, & l'argent reprit sa premiere couleur. Ces pierres de ponce, qui sortirent de la, couvrirent tellement la mer de l'Archipel, que durant quelque temps, quand il regnoit de certains vents, il y avoit des ports qui en estoient bouchez, en façon qu'il n'en pouvoit sortir aucune barque, pour petite qu'elle fut, que ceux qui estoient dedans ne se fissent le chemin au travers de ces pierres de ponce avec quelques pieux; & on en voit encor à present par toute la mer Mediterranée, mais en petite quantité, cela s'estant dispersé ca & là. Senèque raconte en une de ses epistres, que Santorini est bastie sur des mines de souphre, & ce sont elles, qui fournissent asseurement la matiere pour allumer ce feu. On dit qu'Alexandre le Grand mesura la mer en cet endroit, & n'y trouva point de fond. Il y a pourtant une petite isle appelée Firesia, à la pointe de laquelle on peut donner fonds, & point en aucun autre endroit.

It has been often observed, that upon the falling of thunder there has been produced in the air, near the places where it fell, a strong odour of burnt brimstone. And I remember, that being one night at a town built almost upon the great lake of Geneva, anciently called *Lacus Lemanus*, the thunder was so violent, as much frightened the inhabitants; though (by reason of the neighbourhood of the high mountains of Savoy and Switzerland) thunders be very frequent there: and the next day I had a great complaint made me, of the strong stink of sulphur, produced by the thunder, that fell hard by into the lake, and was ready to overcome, by its smell, even a soldier, that stood centinel near it.

On July 24, An. 1681, the ship Albemarle, whereof Mr. Edward Lad was then master, being an hundred leagues from cape Cod in latitude 48. about 3 P. M. met with

with a thunder storm; the lightening burnt the main-top-sail, split the main cap in pieces, rent the mast all along. There was in special one dreadful clap of thunder, in report bigger than of a great gun, at which all the ship's company were amazed: then did there fall something from the clouds upon the stern of the boat, which it broke into many small parts, split one of the pumps, the other pump much hurt: it was a bituminous matter, smelling much like fired gunpowder: it continued burning in the stern of the boat. They did with sticks dissipate it, and poured much water on it, and yet they were not able, by all they could do, to extinguish it, until such time as all the matter was consumed. But the strangest thing of all is yet to be mentioned.

WHEN night came, observing the stars, they perceived, that their compasses were changed. As for the compass in the biddekel the north point was turned clear south. There were two other compasses unhung in the locker in the cabin, in one of which the north point stood south like that in the biddekel. As for the other the north point stood west, so that they sailed by needle, whose polarity was quite changed. The seamen were at first puzzled to work their vessel right, considering, that the south point of their compasses was now become north; but after a little use it was easy to them: thus did they sail a thousand leagues. As for the compass, wherein the lightning had made the needle to point westward; since it was brought to *New-England* the glass being broken, it has, by means of the air coming to it, lost its virtue. One of their compasses, which had quite changed the polarity from north to south, is still extant in that country, in the hands of Mr. *Increase Mather*; the north point of the needle doth remain fixed to this day, as it did immediately after the lightning caused the alteration.

AN industrious gentleman, that was long an eminent planter of trees, wherewith he furnished many of his neighbours, presented me with a piece of a branch, that seemed to have had a slit, for it reached thorough the bark almost to the very wood, from one end to the other, but had now the lips of the wound overgrown on each side with new bark: of this kind of gashes, he told me, he found in other branches of the same tree, which made him think, that some envious knave had done this in spite: but, considering the circumstances more curiously, he found that conjecture much discountenanced by some of them, and suspected, that these wounds must have been made by some designless agent. For by his own observations, and those of his friends, it appeared, that these fissures are to be met with, not only in divers others of his own trees of differing kinds, and in differing plantations, but also in the trees of several others, which, though growing in the same country, were remote enough from his: so that it having been observed with some wonder, that, in the foregoing season, lightnings had been very numerous and frequent, he and his friends concluded, for reasons that need not be here repeated, that the above-mentioned gashes were some of the odd effects of those lightnings, which kept me from wondering at his negative answer, to the curiosity I had to know, whether all these wounds of the trees looked the same way, as east or west, north or south. For I had formerly observed, that the same fulmen, or flash of lightning reaching to the earth in the form of fire, appeared by the recent effects, as well of its impetuous motion, as of its violent heat, to have moved in an irregularly winding-line; which made me compare its motion to that of a squib, and helped me to solve some odd phænomena of lightning, that this is not the fittest place to discourse of: the foregoing mention of what happened to the trees, being designed, partly to preserve the memory of an unusual phænomenon, and partly to shew, that, whatever is wont to happen in animals, lightning is not always destructive or corruptive of vegetables, since the wounds
inflicted

inflicted to trees were happily cicatrised, and did not kill or poison the plants And whether this phænomenon were produced by some mineral exhalations kindled in the air, or by the violent and irregular motion of some such substance, or by both together, the phænomenon will be pertinent to the subject or design of the present tract.

T I T L E XIII.

Of celestial Influences or Effluvia in the Air.

To Mr. HARTLIB.

DEAR SIR,

I SHALL not, I hope, altogether forget the charge, which you have been pleased to lay upon me, in reference to the consideration of all winy liquors, their affections, and the several distempers incident to them, with my thoughts about the preserving of them, so as may best retard the quickness of their motion, and hinder their dyscrasy and corruption.

To which end an exact scrutiny into the air, its quality, temperament and motion, and an enquiry of the efficacy and force, that this hath upon all such bodies, will be in some measure necessary.

AND this puts me in mind to leave one request with you, *viz.* to beg your assistance and countenance on all occasions to Mr. *Streete*, when he shall at any time wait on you, who both as to his undertaking, and to the modesty and simplicity of his spirit, doth very much emulate our so much joint esteemed friend Mr. *Mercator*, who, though he may differ from the former, in reference to his method, or to some of the profounder parts of learning; yet I think it very possible to reconcile them in the main, and cannot but expect something extraordinary in the asserting and perfecting of the theory of the planets, will be brought forth between them, which I should the more gladly see, by how much most scholars complain of it, as of a thing hitherto wanting, by how much also I guess, that, having the examples of so many who have already attempted the same thing in vain, they will find themselves the more constrained to lay down some new choice singular and undeniable hypothesis, for the better invitation of the admittance of their opinion among learned men, although such a work be no less necessary also for other reasons.

FOR, if we assert not the theory of the planets rightly, and upon such grounds as are indubitably demonstrable, we shall never be free from errors and disagreements in opinion about their motions, and the right calculation of them.

AND if we mistake in either of these, we must mistake of the true place in the heavens, in which each planet is, or constantly ought to be: and if we at all err in our judgment of their due places, it is impossible we should assert their several aspects, and the mutual influences and virtues they have (through this) one upon another: and so the physical use of their motions falls to the ground wholly, or at least becomes subject to very much uncertainty.

AND truly, if there be no such use at all of the motions of these bodies, as that which I may call physical, *viz.* for predicting, and for (in some measure) determining, the affections, dispositions, and alterations, that are introduced into several things here, either immediately, or into the air immediately, by reason of the course of these superior bodies, it would very much lessen and depreciate with me that toil, cost, pains, watchings, and continual exercises and endeavours, that have been used

for the gaining of exact observations in astronomy. Seeing, when we have done all, and obtained all beyond the mere bare knowledge of them, we can propound no end, benefit, use, or advantage, that may recompense the trouble and pains bestowed upon them (at least upon some of them), nor so much as any real or particular relation between us and them; and if so, we know them only to know them.

BUT we shall at present presume the contrary, and therefore shall crave leave to say, that although several objections are commonly brought against any such use or application of these bodies, or of their power, influence, or motions, which are occasioned partly by the superstition and paganism incident to this kind of doctrine, partly by the imposture, ignorance, and want of learning, generally observed in the persons professing this knowledge, partly by the manifest mistakes and uncertainty, that there is in the predictions of this nature, and partly by the inexplicableness of the way or manner how they come to affect one another, which admits not, as many conceive, of an easy, visible, or familiar demonstration: yet all these objections, if thoroughly examined, do not, as we humbly conceive, really null or take away the possibility of the thing simply, but are raised rather against the enormities and imperfections, that are confessed to be in it; and it may, notwithstanding all those objections, still be certain, that these celestial bodies, (according to the angles they make one upon another, but especially with the sun or with the earth in our meridian, or with such and such other points in the heavens) may have a power to cause such and such motions, changes, and alterations, (stronger or weaker, according to the nature of the angle) as the extremities of which shall at length be felt in every one of us: and this may be evidenced, 1st, by undeniable experiments, not only from things inanimate and vegetative, but from the undoubted observations of physicians, as well in several chronical as acute distempers, and more eminently in all lunatic, epileptic, paralytic, or lethargic persons. 2dly, It may further admit of a demonstration; for if the extreme motions of physic be generation and corruption, and the mean motions rarefaction and condensation, allowing then these bodies to have a share in promoting the mean motions, (*viz.*) of rarefaction and condensation, we shall or may soon be convinced, that their effects then upon all other things here cannot but be exceeding considerable.

FOR the better understanding of which, I shall offer a little more largely to you my conceptions, *viz.*

THAT, to speak properly and simply, I take generation and corruption to be the extremes of motion, rather than motions themselves; for the scope, intentions, or effects, of all physical motions (strictly so taken) are only to one of these ends, *viz.* either for generation or corruption; and these two are they also, which limit and bound all motion; for beyond these metes there is no physical progression, and therefore these two must be the true *termini*, as well *à quo*, as *ad quem*, of all such motion, seeing all things are corrupted to be generated, and all things generated are at length corrupted.

BUT if these be rather the *termini* and extremes of motion, than motion itself, we must acknowledge there are motions, which nature useth as means, between these two extremes; which mean motions must be as opposite also one to another, as the two extremes. Otherwise we should never be at a certainty, which way nature intends by her motion: otherwise also we must say one and the same course, or one and the same thing in nature, may simply and of itself be the immediate cause of generation and corruption, of life and of death, of hardness and softness, which is absurd and impossible.

Now as these two motions of rarefaction and condensation are opposite one to the other, as is required, so do they square to all other the instruments and phænomena in nature, (*viz.*) the one answering to heat, the other to cold; the one to hardness, compactness, and aridity, the other to gentleness, softness, sweetness, maturity, &c.

FOR which reasons therefore, as well as for many other, which might be urged, (if insisted on) we do conclude, (submitting it nevertheless to be examined) that generation and corruption, rarefaction and condensation, is the simplest, plainest, and truest analysis, that can be found in nature, for all physical motions, as unto some of which all motion, purely physical, may (as we humbly conceive) without straining, be immediately referred, and as by and through which all may likewise with as little difficulty be resolved.

AND having laid this as a second argument, we say thirdly, that it cannot be denied, but all the affections and dispositions of moisture, heat, cold, drought, the course of all winds, showers, thundering, or whatsoever else is used by nature, to produce these two general and universal effects of rarefaction and condensation, do in great measure, if not wholly, depend upon, and are altogether regulated by, the course, motion, position, situations or aspects, of the superior and celestial bodies or planets. And therefore, 4thly, we say, that every planet hath its own proper light: and as the light of the sun is one thing, the light of the moon another, so every planet hath its distinct light, differing from all the other. Now we must either say, that this light is a bare quality, and that the utmost use and end of it is only to illuminate; and that there is no light but is accompanied further with some power, virtue, or tincture, that is proper to it; which if granted, it will inform us then, that every light hath its own property, its own tincture and colour, its own specific virtue and power; and that, according to the several bodies of light, there are several properties, tinctures, and powers; and that as one star differs from another in glory, (according to the apostle) so one star and one planet differs from another in its virtue, in its colour, in its tincture, and in its property.

AND consequently, that those eminent stars and planets, that are in the heavens, are not to be considered by us as sluggish inergetical bodies, or as if they were set only to be as bare candles to us, but as bodies full of proper motion, of peculiar operation, and of life; the sun not only shining upon the rest of the planets, but, by his quickning warmth, awakening, stirring, and raising, the motions, properties, and powers, that are peculiar to them. According therefore to the angles they make with the sun, and according as they are more or less enlighthened by him; according also as they are at the same time more directly or more obliquely, more remotely or more nearly, situated and placed in respect to us; so must the effects of the powers, virtues, and tinctures, that are proper to them, be more or less felt by us. 5thly, For the manner of the planets transmitting these their properties and powers, and of their affecting other bodies at so remote distance, there is nothing begged or required in it, that is insuperable to a man's apprehension or belief: seeing,

1. WE affirm not any property, operation, virtue, or power, to be transmitted from any of the said planets, but what doth descend with its light, and is the real property of its light.

2. No man judgeth, that the light of any planet, or of the sun itself, is refracted, or by any other means weakned, hindred, or impaired by the æther, (or that substance which fills up the space between one planet and another) through which it passeth; but that it doth descend whole directly and unrefracted unto (or upon) our atmosphere.

3. BUT

3. But whatsoever is received by the atmosphere is also received by the thin and subtle air, that is contiguous to the atmosphere: and this air therefore cannot but be capable of being moved, stirred, altered, and impressed by these properties, virtues, and lights, as penetrating each part of it.

4. Not only the air, by reason of its thinness and subtilty, is capable of being thus penetrated, moved, and altered, by these planetary virtues and lights; but forasmuch also as our spirits, and the spirits likewise of all mixed bodies, are really of an aërious, ethereal, luminous production and composition; these spirits therefore of ours, and the spirits of all other bodies, must necessarily no less suffer an impression from the same lights, and cannot be less subject to an alteration, motion, agitation, and infection through them and by them, than the other, *viz.* the air: but rather, as our spirits are more near and more analogous to the nature of light than the air, so they must be more prone and easy to be impressed than it. And if our spirits, and the spirits of all mixed bodies, may be altered, changed, moved, and impressed by these superior bodies, and their properties; then these spirits being the only principles of energy, power, force and life, in all bodies wherein they are, and the immediate causes through which all alteration comes to the bodies themselves; it is impossible therefore spirits should be altered and changed, and yet no alteration made in the bodies themselves: and therefore a less limit or extreme cannot be set to the power or operation, or force of the superior bodies upon the inferior, than what must terminate at length into the very bodies themselves.

5. As a further confirmation or proof of this, in reference at least to ourselves, I shall offer to your consideration the accidents, that often happen to men, by the mere air, as convulsions, cramps, blastings, lameness, colds, many of which endure a man's life-time; and which (with many bitter infirmities, that sometimes seize upon a man, while standing, walking, or lying in the air) are rarely or never felt or discerned at the instant of their approach or insults upon a man, nor yet accompanied with the sense of any excess in the air for heat or cold at that time, and therefore not well referrible to any cause in the air, if not to the power of those properties and operations of the celestial bodies that we speak of; and this I submit to the judgment of common experience.

6. LASTLY, as the sun shining on the rest of the planets doth not, as we said, only barely illuminate their bodies; but besides this, through the power, virtue, and activity it hath, doth also raise, excite, awaken and stir up the several properties and dispositions, that are in those several and respective bodies, whereby they are more lively and effectually brought forth upon us; so we are to suppose it is in reference to this our planet, which is the earth, which is not only enlightened, warmed, cherished and fructified, by the power, virtue, and influence of the sun, but hath its proper magnetical planetary virtue also fermented, stirred, agitated and awakened in it, which it remits back with the reflected light of the sun; and together with this magnetic planetary property of the earth, which is stirred and raised by the sun, are awakened also the feminal dispositions, odours, and ferments, that are lodged in, and proper unto, particular regions or places, which do likewise emit and diffuse through the air, as their several and respective benign, grateful (so their several malignant, congelative, and fracedonous) natures and qualities.

AND hence therefore, though the air, its temperament, disposition and quality in general, is to be looked at according to the motions, influences, and aspects, of the several superior bodies; yet the particular healthfulness and unhealthfulness of the places, the evil disposition of the air, evenings, nights, and early in the mornings, in some parts more than in others; the superabundant moisture, excessive winds, droughts,

or other seasons proper to one country, and not to be observed in another neighbouring to it; all these are rather to be allowed and referred to those odours, vapours, and exhalations, that are, through the power of the sun or other planets, drawn forth from their particular seats into the air, from the planets themselves.

AND thus I have hinted, as well as I may, at the solutions of all the phenomena pertaining to this matter, that I can think of.

And if this be so, then wholly to neglect this physical use (and consideration) of the motion of these bodies, and either to reject it, because of the superstition that hath been mixed with it, or to exclude it from all manner of care, and from all other further scrutiny, as a thing not worth our enquiry or search at all after, is as great an extreme on the other hand, and a mistake, that must not pass untaxed among learned men.

You did not expect, I am sure, I should have adventured into so particular an apology for astrology; nor did I intend it, when I begun my letter; nor do I now aim to justify any thing farther, than what may properly, if not necessarily, fall into the consideration of natural philosophy, being indeed much induced to think, that (were the theory of the planets so exactly stated, so perfectly or so undeniably demonstrated, that we might be sure we rightly understood the place, course, and position, of each of their bodies in the heavens) this other doctrine of their physical use, with the weight, dignity, extent, considerableness or inconsiderableness of it, would soon confirm and demonstrate itself by the evidence and proof of itself; especially if any will please to take the pains to calculate these motions for his own private use, and according to the meridian he was in, and so compare them with his own observations of the change and alteration of the air from day to day. Which doubtless, as it is the way at first taken by the ancients, to find out their efficacy, (I mean the making such a constant observation, and keeping such a diary) so the doing of that again, and giving us first an history or diary of the observations of the weather, and its changes in all respects, and then an account of the several places, motions, or aspects, each day, of the several bodies of the heavens, with the agreements, doubts, or disagreements, that these bear one to another, and that must necessarily rise thereupon, would be that, that could not but prove both satisfactory and delightful to us in this great point, about their physical power and use.

AND the commodity of this in our æconomical or civil concerns, in husbandry, in gardening, in physic, and to the producing many other very stupendous effects, cannot possibly be so well credited or discerned as it would, if some such plain foundation and demonstration of the power of these bodies in general were laid. Which methinks we should be much the more encouraged to undertake, having an advantage given us in this age, beyond what most ages ever had, by the use of those rare instruments, that they call the thermometers, or weather-glasses.

AND truly when I consider, that things of the greatest consequence do oft-times depend upon the most common observations; and that matters of the highest improvement do receive their beginning from mean, small, ordinary experiments; I would have no man, who hath leisure, opportunity, and time, to think it a slight thing to busy himself in collecting observations of this nature. It being much more commendable for a man to preserve the history of his own time, though but in the observation of the motions of this kind, than to say, upon every occasion that offers itself, this is the hottest, or this is the coldest, or this is the rainiest, or this is the most seasonable or unseasonable weather, that ever he felt; whereas it may perhaps be nothing so.

AND if there were no other use, yet observations of this nature would much conduce to compleat the natural history of any place; as we may observe by that learned author, who writ *Historiam Naturalem Brasiliæ*; and who, to prove not only the habitableness, but healthfulness, of that climate and country, exhibits the account of every day's weather, observed by him for many years together, and so the agreement of it to that temper, which we account healthful.

BUT the instituting and perfecting of accurate observations of this nature, by the help of several large and exact thermometers, placed in several rooms, or exposed after some convenient manner to the air itself, would be a more noble and useful undertaking than ordinary. I say, the doing this accurately, by large and exact glasses, by placing several of them, either together, or at some fit distance one from another; it being much to be lamented, and that which I cannot but complain to myself of, that no improvement considerable hath, as I can learn, been made by any man, of these glasses, either in our own country, or any where else, since their first invention, (but only to hang them in a room for ornament sake) there being many things yet wanting, that were much to be desired for the perfecting of them. For,

1. NONE hath hitherto given us the best proportions between the diameter of the head, and the diameter of the bodies or cylinder, although this be indeed the very first consideration, and that which is most necessary in the use of these instruments; for as by how much the bigger the cylinder is, and by how much the lesser the head, by so much the more slow and imperceptible the air's alteration and motion will be; so by how much the bigger the head, and smaller the cylinder is, by so much the more quick, subtle, and discernible, will every small difference of the air appear; which therefore, being on both sides capable of an extreme, ought to be regulated necessarily according to some mean.

2. ADMITTING a mean or convenient proportion between these two diameters, to be as one to 16, or one to 24; we in the next place do no less want the fittest proportion for the length of the cylinder, which must doubtless also be varied answerably, as we vary the proportion of its diameter; the smaller cylinder in proportion to its head requiring the greater length, the bigger cylinder on the contrary the shorter length.

3. I HAVE not hitherto seen any cylinder, that hath been well graduated, 12 or 16 degrees being the most, that are set upon the common weather-glass; whereas, to the making of accurate observations, it would require a cylinder to be divided into at least 360 parts; though I think it neither unreasonable nor unpracticable, to have one divided into 1000 parts, allowing but 10 degrees to each inch, which is no unusual division, seeing such an one will much better discover, not only the small (but the more sudden and remarkable) changes of the weather (which are of chiefest use) than any others, that are common and ordinary.

4. ALTHOUGH no liquor ought to be used in these glasses, that is subject to frost, yet we have little or no account what those liquors are, that might be best or fittest for the accurate making of those experiments, whether those, whose property it is somewhat to attract the air, and so to preserve themselves in at least their first quantity, as *oleum sulphuris per campanam*, *ol. vitrioli*, *liquor salis tartari*, &c. or 2dly, whether those, whose parts are finest, subtlest, and nearest of kin to the air, such as is spirit of wine, spirit of terebinth well rectified, and, according as there is occasion, still fresh supplied. Or 3dly, whether those, that are of a middle nature, as strong spirit of vinegar. Or 4thly, whether instead of these, and beyond these, it may not be best to use only well-refined quicksilver.

ALL which several particulars, as they are necessary, and ought to be first ascertained, yet they are but preliminary to the experiments themselves.

IN the making of these experiments themselves, therefore, it would be convenient, 1st, That several thermometers of one proportion, length, and graduation in the cylinders in all respects, as near as may be, were set in one frame together, either with one and the same, or with variety of liquors. 2dly, That several of these frames were set in several rooms; and that some were exposed immediately to the air itself; yet so as it may be conveniently sheltered from the actual rays of the sun, and from the injury of storms, rain, and winds.

IN the history itself there cannot be too much care and exactness; provided the air of the chimney, cranny of a wall or door, breath of people, or other such accidents, do not interpose to deceive a man's observation, which must be circumspectly foreseen and considered.

THE proportion between the warmth of the day and night in constant weather; the agreement or disagreement of the motion of the air, with the motions of the superior bodies, in all uncertain, changeable, and inconstant weather; the efficacy or inefficacy through these in foretelling of winds and rain; the air its particular disposition under thunder, under times of mildews or blastings, eminent eclipses, conjunctions, with many other the like particulars, which will of themselves be incident to an ingenious, diligent, apprehensive person, may be the subject of this history.

I SHALL not digress so far, as to tell you, what other things may be done by the help of this excellent instrument, this being not pertinent to our present purpose.

YET it is certain, that *Drebbel*, that great, singular, learned mechanic, did, by the help of this instrument, make a dial continually to move of itself, regularly shewing both the time of the day, and other motions of the heavens; did also make an automatus instrument of music, and found out a furnace, which he could govern to any degree of heat: but whether these have died with him, or how far the meditations of others have wrought upon them, I shall humbly refer to a more leisurable enquiry. And if you can inform me among any of your acquaintance or correspondents, I should be glad to hear and to learn any thing of this nature, or relating to the further use, experiment, or improvement of this rare little instrument, or to the further clearing, ventilating, or discussing the theory or doctrine of the planets, or the physical use and power of these bodies, that we have thus briefly made an essay of. Thus far that letter.

THEY have a received tradition in *Java*, and probably in divers other islands of the *South Sea*, that the beams of the moon are wont to cause contractures in the body of those men, that stay too long exposed to them: the truth of which tradition was lately confirmed to me by an ingenious doctor, that with applause practised physic in those parts; who assured me, that he had observed, that upon the account before-mentioned some were made lame, or else had some of their limbs contracted for divers weeks, and some for many months, or even a longer time. And when I asked him, whether he had at any time been subject to that mischief himself? he answered, that, whilst he was a novice in those parts, after a very hot day, he laid himself down, very slenderly covered, to sleep (according to the custom of the place) near the door of the house he lodged in; but, being unacquainted with the tradition, he unskilfully chose a place, upon which the moon could fully beat for a good part of the night, which being past before he waked, when he went to rise, he found his neck so stiff, that he was scarce able at all to stir it; and his mouth was so drawn awry, that it was hideous to behold, and continued so unsightly, that shame forced him to keep within for some days, during which he made use of brisk aromatic medicines, by

whose help he got off a contracture, that used to stay very much longer with others. And when I asked him, if these distempers were not occasioned rather by the coldness of the night and subtilty of the air, than the operation of the moon's beams? he answered me, that it was generally observed, that the other causes, without the direct beams of the moon, were not wont to produce such bad effects; and that his landlord, when he saw his mouth awry, told him, that if he had made him acquainted with his design to pass the night in the open air, he would have prevented this mischief, by lodging him in a place unexposed to the moon's light.

T I T L E XIV.

Of the Height of the Atmosphere.

T I T L E XV.

Of the Motion of the Air, and of Winds.

Extract of a Letter from Fort St. George, dated January 23, 1668.

ALTHOUGH the bar of *Porta Nova* proved more shallow and dangerous than we were informed, yet she (our ship) got safe in thither; and it was well she did so. Had we kept her here, there had been no possibility of her escape from perishing in a dreadful storm, or rather hurricane, which happened here the 22d of *November*; the like hath not been known here in any man's memory. The tempest of wind and rain was so exceeding violent, that nothing could stand before it; men and beasts carried into the sea by the violence of the winds and floods; the generality of the houses in this and the neighbour towns were ruined; scarce any trees left standing in gardens or elsewhere; the wall in this town laid flat in several places; your godowns and other houses in and about the fort uncovered, and exceedingly shattered; no place in the fort, where we could keep our persons, books or papers free from the wind or rain; nor scarcely any doors could stand against the violence of it; and we hourly feared the falling of the fort down upon us, it was so exceedingly rocked; and yet abroad we could have no shelter, nor were able to stand against it. The repairing of the damage will necessarily require a great charge, which at first we thought would have amounted to 3000 pagothes; but hope it will come short thereof.

CAPTAIN *Brookehaven* told me, that about the island *Mauricius*, hurricanes were the most frequent of any place he knows; and that near that island he met with one which lasted four days in all: in one of which days the storm had seven paroxysms or exacerbations, which the seamen call frights of weather, each of which he observed to differ two points of the compass from the preceding, by which means the surface of the sea, by the collision of the waves, became to be all white, as if the ship had been among rocks. He added, that the storm made the day exceeding dark; and that the noise was rather like that of thunder, than of wind, insomuch that those on the shrouds could not hear those on the deck.

A LEARNED physician, that travelled into *America*, affirmed to me, that those countries

countries only have constant winds from the land in the night, which are furnished with hills; and therefore the *Barbadoes* wants such winds, because it has no hills.

One of the East-Indian committee, (who had lived years in the island of *Teneriff*) answered me, that he usually observed there the breezes to come in from the sea about nine of the clock in the morning, and that about two hours after sun-set, there blew a sharp land-wind, every way from the island to the sea-ward, which continued all night till the next morning.

A LEARNED traveller answered me, that though the air were generally calm and clear at the top of the mountains, yet sometimes he had met there with winds considerably strong.

In Lettere di Venetia.

MARTEDI sui li 29 Agosto 1679, alle hore 19, incirca si leuoleuò nelle paludi della villa di Fauis del dominio Cesareo tre miglia lontana da Palma Nova dominio Veneto un vento chiamato Biffa Boua, che allargandosi per circa cinquanta passi scorse con tanto empito, e furore, che portò per aria diversi buomini, che tagliavano il fieno in quei prati, e anco alcuni carri carichi di fieno con i buoi precipitandoli assai lontano con la rouina delli animali, de carri, e degli buomini, e passando per i campi sbarbicando ogni sorte di piante le portò per aria gettandole molti passi lontano, rendendo la terra per oue scorse così arsa, che pare non vi s'ii mai stata piantata cosa alcuna. Arrivò nella villa detta Bagnaria del dominio Veneto doue gettò à terra molte case fino à fondamenti, et altre discoperse, e rouin portando per ari atavole, travi, et ogni altra cosa che era dentro esse case restando mal trattate molte persone senza però la morte di alcuno.. Fuori di dettata villa vi è una chiesa chiamata S. Tomaso, la quale restò scoperta, e rouinata una parte del muro portando via il campanile, e campane che nel giorno seguente non si erano per anco trovate;—di là si portò verso Senigiano dominio Veneto, e rouinò tutta la campagna senza danno però della villa, mentre li passò poco lontano, e girando poco lungi dalla villa stessa spiantò da fondamenti un palazzo del d. co. Horatio Strasoldo, nel quale gli amazzò ogni sorte di animali che vi erano, portando per aria li mobili e fino le botti, esterminando parre della possessione. Non restorono però offese persone, perche erano alla campagna à lavorare, e nel camino getto pure à terra due altre case che sono nel taglio per andare à strasoldo spiantandole affatto con la morte di una donna, d'un fanciullo, e diversi animali.

Di là voltò verso Palma, et arrivando fino alle mura della fortezza già verso la villa di Privano mezo miglio distante quale rouinò la meta, spiantando da fondamenti bellissimi palazzi, portando per aera travi, tavole, et ogni altra cosa con la morte di molti, quantità di feriti, e diversi strapazzati con far alla campagna di molto male. Di poi scorse nella villa di Visco dominio Imperiale, e tra li altri danni fatti rouinò tutto il palazzo novo del D. Marco Foscolini gentiluomo di Cinidal, nel quale essendoni una gran remissa da Carozze, la di cui porta bavena tre Cadenazzi, E entrando il turbine per li balconi gettò la carrozza con tanto empito nella porta stessa che la ruppe, e portò fuori la carrozza tutta fraccata gettandola sopra un muro della corte assai alto, portando il cielo della stessa mezzo miglio lontano, e vertò nel medemo palazzo ferito, e mel trattato un servitore di esso foscolini, di cui rouino pure una braida, E un brolo essendo in detta villa restati due morti, e diversi feriti;—s' inoltrò poi nella villa di S. Vido di Crauglio stato Imperiale, la quale rouino tutta affatto senza restarvi nemo una casa, portando per aria coppi, travi, legne, sassi, e mobili con la morte di moltissime persone, e moltissimi feriti e rouinati, et in detta villa non si può andare, ne con carri, ne con cavalli per la grande moltitudine di rouinazzo, arbori et altro che hanno atraver-sato le strade, essendo rimasti morti gran numero di animali—.

Da questo luoco si portò verso villes villa Imperiale buona parte della quale gettò à terra
per

per andar al territorio di Monfalcone con la morte di molte persone, et quantità di animali con lasciar le campagne per dove è passata senza piante, è come strada battuta——.

Hà danneggiato anco altre ville, ma leggiermente, ne per anco si sà quello haverà fatto piu avanti nel detto territorio.

Questo successo hà lasciato un spavento grande in queste parti, essendosi vedute cose incredibili mentre piovevano sassi, tavole, arbori, travi, coppi, buomini, donne, fanciulli, botti, sorgbi, uva, galline, animali, et in conclusione ciò che incontrava portava per aria con un rumore, è fracasso così grande, che faceva terrore, essendo per dette ville un concorso grande di popolo vicino per vedere cose che, si rendono incredibili.

DOCTOR B. answered me, that though the eastern winds blew near $\frac{1}{4}$ of a year at Tangier, yet they seem not to reach far into the inland country, where he observed them to be very unfrequent.

AN ingenious gentleman, who is owner of a mine or two near the sea, being asked by me, whether he could by any peculiar change appearing in the deeper parts of the mines, foretel any alterations of weather? he answered me, that the only presage he had constantly observed, was of the change of the wind. For many hours before the wind was to shift from some other corner, and get into the south, the water at the bottom of the mine would appear manifestly more troubled, or less limpid than before: and when the wind was to blow from the east, he was usually forewarned of it by an unusual degree of clearness in the waters, which would appear more diaphanous than ordinary, though the south wind had not immediately before operated on the waters. The depth of the mine was between fifteen and twenty fathom.

HE told me, that the hurricanes about Goa are observed to come usually but at two seasons, about the beginning of March, and the 4th of October.

T I T L E XVI.

Of the Air as the Medium of Sounds, and of Sounds and Noises in the Air, and particularly Thunder; and of the Air's Operation on the Sounds of Bodies.

THIS variety of the air is the cause of most dreadful thunders; which when Gregory described, he astonished his hearers. For upon the rising of several tempests, all together, the sky is of a sudden covered over with black and thick, as it were, globes of smoky clouds: by and by the thunder breaks forth on every side, rattling continually with lightning, as incessantly flashing, enough to amaze the most resolute and most accustomed to the noise. *Ludolph's Hist. of Ethiop. L. I. c. 5.*

THE string of a viol has been by Mr. F. observed to give a sharper sound against or in rainy weather, by almost half a note.

MR. F. also assures me, that more than once or twice it has happened to him, that having put up false strings in his pocket, to make frets of, as judging them useless for any other purpose, the want of strings having driven him to make use of those, he has found them not false any more, but good strings. And also that he observes some strings apter to receive a tension from the moist air, than others are.

T I T L E XVII.

Of the Weight of the Air.

A short Account of the statical Baroscope, imparted by Mr. Boyle March 24, 1665. In a Letter to Mr. H. Oldenburg.

AS for the new kind of Baroscopes, which not long ago * I intimated to you, that my haste would not permit to give you an account of, since your letters acquaint me, that you still design a communicating to the curious as much information as may be, in reference to baroscopes, I shall venture to send you some account of what I did not name (in my former letter) to you.

THOUGH by a passage you may meet with in the 19th and 20th pages of my *Thermometrical Experiments and Thoughts*, you may find, that I did some years ago think upon this new kind of baroscope; yet the changes of the atmosphere's weights not happening to be then such as I wished, and being unwilling to deprive myself of all other use of the exactest balance †, that I (or perhaps any man) ever had, I confess to you, that successive avocations put this attempt for two or three years out of my thoughts; till afterwards returning to a place, where I chanced to find two or three pair of scales I had left there, the sight of them brought it into my mind; and though I were then unable to procure exacter, yet my desire to make the experiment some amends for so long a neglect, put me upon considering, that if I provided a glass bubble, more than ordinary large and light, even such balances as those might in some measure perform what I had tried with the strangely nice ones above-mentioned.

I CAUSED then to be blown at the flame of a lamp some glass bubbles as large, thin, and light, as I could then procure; and choosing among them one, that seemed the least unfit for my turn, I counterpoised it in a pair of scales, that would lose their æquilibrium with about the 30th part of a grain, and were suspended at a frame. I placed both the balance and the frame by a good baroscope, from whence I might learn the present weight of the atmosphere. Then leaving these instruments together, though the scales being no nicer than I have expressed, were not able to shew me all the variations of the air's weight, that appeared in the mercurial baroscope; yet they did what I expected, by shewing me variations no greater than altered the height of quicksilver half a quarter of an inch, and perhaps much smaller than those: nor did I doubt, that if I had had either tender scales, or the means of supplying the experiment with convenient accommodations, I should have discerned far smaller alterations of the weight of the air, since I had the pleasure to see the bubble sometimes in an æquilibrium with the counterpoise; sometimes, when the atmosphere was high, preponderate so manifestly, that the scales being gently stirred, the cock would play altogether on that side at which the bubble was hung; and at other times (when the air was heavier) that which was at the first but the counterpoise, would preponderate, and upon the motion of the balance, make the cock vibrate altogether on its side. And this would continue sometimes many days together, if the air so long retained the same measure of gravity; and then (upon other changes) the bubble would regain an æquilibrium, or a preponderance; so that I had oftentimes the satisfaction, by look-

* See number 11. p. 185. of the Philosophical Transactions.

† The scales here meant were before competent eye-witnesses made to turn manifestly with the thousandth part of a grain.

ing first upon the statical baroscope (as for distinction's sake it may be called) to foretel, whether in the mercurial baroscope the liquor were high or low. Which observations, though they hold as well in winter, and several times in summer, (for I was often absent during that season) as the spring, yet the frequency of their vicissitudes (which perhaps was but accidental) made them more pleasant in the latter of these seasons.

So that the matter of fact having been made out by variety of repeated observations, and by sometimes comparing several of those new baroscopes together, I shall add some of these notes about this instrument, which readily occur to my memory, reserving the rest till another opportunity.

AND first, if the ground, on which I went in framing this baroscope, be demanded, the answer in short may be, 1. That though the glass bubble, and the glass counterpoise, at the time of their first being weighed, be in the air, wherein they both are weighed, exactly of the same weight, yet they are nothing near of the same bulk; the bubble, by reason of its capacious cavity (which contains nothing but air, or something that weighs less than air) being perhaps a hundred or two hundred times (for I have not conveniency to measure them) bigger than the metalline counterpoise. 2. That according to a hydrostatical law (which you know I have lately had occasion to make out) if two bodies of equal gravity, but unequal bulk, come to be weighed in another medium, they will be no longer equiponderant; but if the new medium, be heavier, the greater body, as being lighter in specie, will lose more of its weight, then the lesser and more compact; but if the new medium be lighter than the first, then the bigger body will outweigh the lesser: and this disparity arising from the change of mediums, will be so much the greater, by how much the greater inequality of bulk there is between the bodies formerly equiponderant. 3. That laying these two together, I considered, that it would be all one as to the effect to be produced, whether the bodies were weighed in mediums of differing gravity, or in the same medium, in case its (specifick) gravity were considerably altered: and consequently, that since it appeared by the baroscope, that the weight of the air was sometimes heavier, and sometimes lighter, the alterations of it, in point of gravity, from the weight it was of at first counterpoising of the bubble of it, would unequally affect so large and hollow a body as the bubble, and so small and dense a one as a metalline weight: and when the air by an increase of gravity should become a heavier medium than before, it would buoy up the glass more than the counterpoise; and if it grew lighter than it was at first, would suffer the former to preponderate: (the illustrations and proof can scarce be added in few words; but, if it be desired, I may, God permitting, send you them at my next leisure.) And though our English air be about a thousand times lighter than water, the difference in weight of so little air, as is but equal in bulk to a bubble, seemed to give small hopes, that it would be sensible upon a balance; yet by making the bubble very large and light, I supposed and found the event I have already related.

SECONDLY, the hermetically sealed glass bubble I employed, was of the bigness of a somewhat large orange, and weighed about 1 drachm and 10 grains. But I thought it very possible, if I had been better furnished with conveniencies (wherein I afterwards found I was not mistaken) to make among many, that might be expected to miscarry, some that might be preferable to this, either for capacity or lightness, or both; especially if care be taken, that they be not sealed up whilst they are too hot. For though one would think, that it were advantageous to rarify and drive out the air as much as is possible, because in such sealed bubbles the air itself (as I have elsewhere shewn) has a weight; yet this advantage countervails not the inconvenience of

being obliged to increase the weight of the glass, which when it includes highly rarified air, if it be not somewhat strong, will be broken by the pressure of the external air, as I have sufficiently tried.

THIRDLY, I would have tried, whether the dryness and moisture of the air would in any measure have altered the weight of the bubble, as well as the variation of gravity produced in the atmosphere by other causes; but the extraordinary constant absence of fogs, kept me from making observations of this kind, save that one morning early, being told of a mist, I sent to see (being myself in bed) whether it made the air so heavy as to buoy up the bubble, but did not learn, that that mist had any sensible operation on it.

FOURTHLY, by reason of the difficulties and casualties, that may happen about the procuring and preserving such large and light bubbles, as I have been lately mentioning, it may in some cases prove a convenience to be informed, that I have sometimes, instead of one sufficiently large bubble, made use of two, that were smaller. And though a single bubble of competent bigness be much preferable, by reason, that a far less quantity and weight of glass is requisite to comprise an equal capacity, when the glass is blown into a single bubble, than when it is divided into two; yet I found, that the employing of two instead of one did not so ill answer my expectations, but that they may for a need serve the turn instead of the other, than which they are more easier to be procured: and if the balance be strong enough to bear so much glass, without being injured, by employing two or a greater number of large bubbles, the effect may be more conspicuous, than if only a single bubble (though a very good one) were employed.

THIS instrument may be improved by divers accommodations. As

FIRST, there may be fitted to the ansa (or checks of the balance) an arch (of a circle) divided into 15 or 20 deg. (more or less, according to the goodness of the balance) the cock resting over-against these divisions, may readily, and without calculation, shew the quantity of an angle, by which, when the scales propend either way, the cock declines from the perpendicular, and the beam from its horizontal parallelism.

SECONDLY, those that will be so curious, may instead of the ordinary counterpoise (of brass employ one of gold, or at least of lead, whereof the latter being of equal weight with brass, is much less in bulk, and the former amounts not to half its bigness.

THIRDLY, those parts of the balance, that may be made of copper or brass, without any prejudice to the exactness, will, by being made of one of those metals, be less subject than steel, (which yet, if well hardened and polished, may last a great while) to rust with long standing.

FOURTHLY, instead of the scales, the bubble may be hung at one end of the beam, and only a counterpoise to it at the other, that the beam may not be burthened with unnecessary weight.

FIFTHLY, the whole instrument, if placed in a small frame, like a square lanthorn with glass windows, and a hole at the top for the commerce of the internal and external air, will be more free from dust, and irregular agitations; to the latter of which it will otherwise be sometimes incident.

SIXTHLY, this instrument being accommodated with a light wheel and an index, (such as have been applied by the excellent Dr. *Chr. Wren* to open weather glasses, and by the ingenious Mr. *Hook* to baroscopes) may be made to shew much more minute variations than otherwise.

SEVENTHLY, and the length of the beam, and exquisiteness of the balance, may easily,

easily, without any of the foregoing helps, (and much more with them) make the instrument far exacter than any of those I was reduced to employ. And to these accommodations divers others may be suggested, by a farther consideration of the nature of the thing, and a longer practice.

THOUGH in some respects this statical baroscope be inferior to the mercurial, yet in others it has its own advantageous conveniencies above it.

AND first, it confirms *ad oculum* our former doctrine, that the falling and rising of the mercury depends upon the varying weight of the atmosphere; since in this baroscope it cannot be pretended, that a *fuga vacui*, or a *funiculus*, is the cause of the changes we observe. 2. It shews, that not only the air has weight, but a more considerable one, than some learned men, who will allow me to have proved it has some weight, will admit; since even the variation of weight in so small a quantity of air, as is but equal in bulk to an orange, is manifestly discoverable upon such balances as are none of the nicest. 3. This statical baroscope will oftentimes be more parable than the other; for many will find it more easy to procure a good pair of gold-scales, and a bubble or two, than a long cane sealed, a quantity of quicksilver, and all the other requisites of the mercurial baroscopes; especially if we comprise the trouble and skill, that is requisite to free the deserted part of the tube from air. 4. And whereas the difficulty of removing the mercurial instrument has kept men from so much as attempting to do it, even to neighbouring places, the essential parts of the scale baroscope (for the frame is none of them) may very easily in a little room be carried whither one will, without the hazard of being spoiled or injured. 5. There is not in statical baroscopes, as in the other, a danger of uncertainty as to the goodness of the instruments, by reason, that in these the air is, in some more, and in some less perfectly excluded; whereas in those, that consideration has no place. (And by the way, I have sometimes upon this account been able to discover by our new baroscope, that an esteemed mercurial one, to which I compared it, was not well freed from air.) 6. It being, as I formerly intimated, very possible to discover hydrostatically, both the bigness of the bubble, and the contents of the cavity, and the weight and dimensions of the glassy substance, (which together with the included air make up the bubble) much may be discovered by this instrument as to the weight of the air, absolute or respective. For when the quicksilver in the mercurial baroscope is either very high, or very low, or at a middle station between its greatest and least height, bringing the scale barometer to an exact æquilibrium; (with very minute divisions of a grain) you may, by watchfully observing, when the mercury is risen or fallen just an inch, or a fourth, or half an inch, &c. and putting in the like minute divisions of a grain to the lighter scale, till you have again brought the balance to an exquisite æquilibrium; you may, I say, determine, what known weight in the statical baroscope answers such determinate altitudes of the ascending and descending quicksilver in the mercurial. And if the balance be accommodated with a divided arch, or a wheel and index, these observations will assist you for the future to determine readily, by seeing the inclination of the cock, or the degree marked by the index, what pollency the bubble hath by the change of the atmosphere's weight, acquired or lost. Some observations of this nature I watchfully made, sometimes putting in a 64th, sometimes a 32d, sometimes a 16th, and sometimes heavier parts of a grain, to the lighter scale. But one, that knew not for what uses those little papers were, coming to a window, where my baroscopes stood, so unluckily shook them out of the scales, and confounded them, that he robbed me of the opportunity of making the nice observations I intended, though I had the satisfaction of seeing, that they were to be made.

7. By this statical instrument we may be assisted to compare the mercurial baroscopes of several places (though never so distant) and to make some estimates of the gravities of the air therein. As if, for instance, I have found by observation, that the bubble I employ, (and one may have divers bubbles of several sizes, that the one may repair any mischance, that may happen to another) weighed just a drachm, when the mercurial cylinder was at the height of $29\frac{1}{4}$ inches, (which in some places I have found a moderate altitude;) and that the addition of the 16th part of a gr. is requisite to keep the bubble in an æquilibrium, when the mercury is risen an 8th, or any determinate part of an inch above the former station: when I come to another place, where there is a mercurial barometer, as well freed from air as mine (for that must be supposed) if taking out my scale instrument, it appear to weigh precisely a drachm, and the mercury in the baroscope there stand at just $29\frac{1}{2}$ inches, we may conclude the gravity of the atmosphere not to be sensibly unequal in both those places, though very distant. And though there be no baroscope there, yet if there be an additional weight, as for instance, the 16th part of a grain, requisite to be added to the bubble, to bring the scales to an æquilibrium, it will appear, that the air at the second place is at that time so much heavier, than the air of the former place was, when the mercury stood at $29\frac{1}{2}$ inches.

BUT in making such comparisons, we must not forget to consider the situation of the several places, if we mean to make estimates, not only of the weight of the atmosphere, but of the weight and density of the air. For though the scales will shew (as has been said) whether there be a difference of weight in the atmosphere at the two places; yet, if one of them be in a vale or bottom, and the other on the top or some elevated part of a hill, it is not to be expected, that the atmosphere in this latter place should gravitate as much as the atmosphere in the former, on which a longer pillar of air does lean or weigh.

AND the mention I have made of the differing situation of places, puts me in mind of something, that may prove another use of our statical baroscope, and which I had thoughts of making trial of, but was accidentally hindered from the opportunity of doing it. Namely, that by exactly poising the bubble at the foot of a high steeple or hill, and carrying it in its close frame to the top, one may, by the weight requisite to be added to counterpoise there, to bring the beam to its horizontal position, observe the difference of the weight of the air at the bottom and at the top; and in case the hill be high enough, at some intermediate stations. But how this may assist men to estimate the absolute or comparative height of mountains, and other elevated places; and of what other uses the instrument may be put to when it is duly improved; and the cautions, that may be requisite in the several cases, that shall be proposed, I must leave to more leisure, and farther consideration.

Weight of
a cubick
inch of
water.

I CAUSED to be made with great care, by a skilful mathematical instrument-maker, a hollow cube of brass, whose every side was as exactly as could be procured an English inch. This we carefully counterpoised in a very good pair of scales, and found it to weigh 11 drachms, 1 grain and $\frac{1}{2}$ (Troy-weight:) then placing it in one of the scales as horizontally as we were able, we warily filled it with clear common water, (of the best sort of that called pump-water) till the surface of the water seemed to lye as level as we could make it, to the brims of the vessel: then weighing it carefully, we found the water alone (for the cube had been counterpoised before) to weigh to $254\frac{7}{8}$ grains: so that in regard it is scarce possible to know, that such a vessel is so filled, as to come nearer exactness, than within a drop or two, I presume we may, without any sensible error, suppose an inch of water to weigh 256 grains, which latter number I rather chuse, because its aliquot parts make it more convenient, and it agrees

agrees well enough with some trials, that I made with solid cubes, to measure the true weight of a cubick inch of water.

THIS done, the vessel was well dried within, and the same scales being well counterpoised, the instrument was so too; and being placed on one of the scales as horizontally as we could, mercury (distilled to have it more pure) was warily put into it, till by degrees it had filled the vessel as to sight; but we neither expected, nor found, that it would be brought to an exact level, and exquisitely fill all the corners of the vessel. But when it seemed to be so well filled, that even a critical eye could not readily find fault with it, though the mercury appeared capable of some accession without overflowing, we weighed the quicksilver itself (for the vessel had been counterpoised before) and found it to weigh 7 ounces, 2 drachms (Troy) which falling somewhat short, (though not very much) of what the above-mentioned weight of the water required, we tried to add a little more quicksilver, without making it run over, and found the encrease of 82 grains; so that now the quicksilver weighed 7 ounces, 3 drachms, 22 grains; but it seemed when the eye was placed in a level with the brims of the vessel, that it was rather a little of the highest, than any way depressed, and yet was not so full, but that we could add 112 grains to the former weight, without making it run over; and perhaps we might have added yet more, but I declined doing it, because the last mentioned accession seemed manifestly to make it so much swell above the brims of the vessel. By all which it is evident, that it is scarce possible to determine precisely, by such hollow instruments, the true weight of a cubick inch of quicksilver. And therefore, since by other ways of trial, I have found the proportion of the weight of mercury to water of the same bulk, to be somewhat less than that of 14 to 1, I think we may, without any considerable inconvenience, suppose the weight of a cubick inch of quicksilver to be 3580 grains, which is near 14 times the above-mentioned weight of a cubick inch of water, and comes near enough to the second or middlemost of the three estimates lately set down; and by the least estimate of all it appears, that a cubick inch of quicksilver weighs $7\frac{1}{4}$ ounces troy weight, that is, 8 ounces averdupois weight: and consequently when the quicksilver of the baroscope, kept up by the counterpoise of the air 30 inches, (as I have observed it several times to be within a month last past) the weight of the air, that is incumbent on an inch square here below, amounts to $18\frac{1}{8}$ troy weight; that is in averdupois weight $15\frac{1}{17}$.

The weight of a cubick inch of quicksilver.

The weight of a pillar of the atmosphere.

As 11 to 14, or rather as 355 to 452, so is the area of a square inscribed in a circle to the area of the circumscribed circle.

HENCE $355 : 452 :: 1 : 1,2732394$.

HENCE if the side of an inscribed square be an inch, that multiplied by an inch renders a cubick inch for the solid content.

IN like manner if the height of a cylinder erected on the circumscribing circle be an inch, the solid content of that cylinder is 1,2732394.

WHEREFORE 1, and 1,2732394 multiplied by the weight of the cubick inch of any kind of metal, give the weight of a cubick inch, and of a cylindrick inch, that circumscribes the same, whence an inch table for both is easily made by continual addition, or for any height propounded, multiplying both by the same.

Mr. Townly's Register, if I misremember not.

November	23	2	28.98
	24	8	29.54
	9	P	28.90
	25	3 $\frac{1}{2}$	80
	27	9	99
October	29	9	28.97
	9	P	29.09
	6	9	28.97
	7	9	60
	8	9	29.05
January	11	9	28.93
	3	P	29.01
	13	8 $\frac{1}{2}$	28.90
	9	P	95
	25	9	29.04
	26	9	28.32
	28	10	29.13
	1	9	28.99
	2	9	82
	3	9	29.08
	9	P	06
	5	10	28.70
	6	10	29.09
	9	$\frac{1}{2}$ P	28.62
	7	8	28.99
	12	10	28.88
	4	P	98
	16	1	29.13
	9	P	28.65
	17	10	14
	21	9 $\frac{1}{2}$	29.05
	22	4	28.99
	9	P	94
	23	9	99
	24	11	29.06
	25	9	28.50
	19	P	29.10

February	29	9	28.90
	9	P	71
	30	8	80
	31	9	30.12
	1	12	22
March	2	8 $\frac{1}{2}$	29.97
	15	9	28.99
	16	9	95
	17	8	29.10
	2	9	28.98
April	4	8 $\frac{1}{2}$	78
	9		86
	12	9	28.80
	9	P	66
	13	8 $\frac{1}{2}$	29.03
June	16	P	28.29
	26	P	78
	3	8 $\frac{1}{2}$	29.03
	8	1	29.18
	8	P	28.86
August	9	7	99
	12	6	28.90
	6	8 $\frac{1}{2}$	29.15
	7	10 $\frac{1}{2}$	28.65
	8	7 $\frac{1}{2}$	29.05
September	12	9 $\frac{1}{2}$	28.98
	29	8	28.96
	3	P	29.08
	30	9	29.19
	1	10	28.63
October	3	8	29.10

In all those papers the mercury was still about 12 of one inch higher than is set down, for the numbers signify only bottom of the cap.

A Register kept by Mr. Locke in Oxford.

	d	h	Th.	Bar.	Hy.	Wind.	Weather at Oxford.
1666. June	24	9	70	29		N E 2	Fair.
		22	76	29 1			Fair.
	25	4	73	29 1		N E 1	Fair.
		10	74	29 1		E 1	Fair.
		15	77	29 1		S E 2	Fair.
	26	9	73	28 8		N 1	Fair.
		12	75	28 7		N E 1	Thunder.
		13	75	28 7		S W 4	Thunder, Rain, Hail.
		14	74	28 8		N 4	Thunder, Rain.
		18	73	28 8		N 1	Clouds, dry.
		22	72	28 8			Fair.
	27	7	70	28 8		N W 1	Rain.
		9	70	28 2		N W 1	Rain.
		16	68	28 8		W 1	Fair.
July	28	9	63	29 1		W 0	Clouds.
		17	67	29 1		N 1	Clouds.
	29	9	63	29 2		N 1	Clouds.
		19	69	29 1		N 1	Clouds.
	30	9	64	29 2		N 0	Clouds
		20	64	29 2		N 1	Fair.
	1	9	57	29 4		W 2	Fair.
	2	11	63	29 3		W 1	Clouds.
		21	67	29 2			Rain.

A Register kept by Mr. *Locke* in *Oxford*.

	d	h	Th.	Bar.	Hy.	Wind.	Weather.
1666. <i>July</i>	3	9	66	29 1		W 1	Clouds.
		22	66	29 1			Clouds.
	4	11	64	28 8		W 10	Clouds.
		17	68	28 7		S E 2	Clouds.
	5	9	65	28 7		S W 2	Clouds.
		23	65	28 7		S W 2	Rain.
	6	9	63	29 1		W 1	Fair.
		16	67	29 1		S W 1	Clouds.
	7	9	67	29 1		S 2	Fair.
		23	72	28 7			Lightning.
	8	9	70	28 8		S W 2	Clouds.
	9	9	66	29 2		S W 2	Fair.
	10	9	66	29 1		S 2	Clouds.
	11	10	67	29 1		S 2	Clouds.
	12	10	66	29 2		S 2	Fair.
	13	10	66	29 3		W 1	Fair.
	14	3	75	28 8		S W 2	Clouds.
	15	9	67	29 1		S W 1	Fair.
	16	11	70	29 1		S W 2	Fair.
	17	5	71	28 8		E 0	Clouds after Rain.
		19	71	28 8		W 1	Rain.
	18	7	62	29 2		S W 2	Fair.
		9	64	29 2		S W 2	Fair.

A Register kept by Mr. *Locke* in *Oxford*.

	d	h	Th.	Bar.	Hy.	Wind.	Weather.
1666. <i>July</i>	19	9	65	29 3		S W 2	Cloudy.
	20	12	67	29 4		W 1	Fair.
	21	8	64	29 4		W 1	Fair.
	22	9	67	29 3		S W 1	Fair.
	23	9	67	29 2		E 1	Thunder. Rain.
	15	7	71	29 1		N E 1	Fair.
	17	7	71	29 1		E 1	Rain.
	21	6	69	29 2			Clouds, Lightning.
	24	9	67	29 2		N 1	Clouds.
	25	9	67	29 2		N 1	Clouds.
	26	6	64	29 3		N 1	Clofe.
	30	23	69	29 3	15		Fair.
	31	7	67	29 3	15	N W 0	Fair.
	15	10	60	29 2	20		Clouds.
	16	9	59	29 2	19	N 1	Fair.
<i>August</i>	29	21	64	29 2	19		
	30	9	59	29 3	19	N 0	Fair.
	31	7	61	29 3	20	N E 0	Fair.
		9	61	29 3	20	N E 1	Fair.
	1	6	55	29 3	17	N E 1	Fair.
<i>September</i>		9	55	29 3	17	E 2	Clouds.
	2	9	52	29 3	16	E 3	Clouds.
	3	9	49	29 4	16	E 2	Fair.

A Register kept by Mr. *Locke* in *Oxford*.

1666. September	d	h	Th.	Bar.	Hy.	Wind.	Weather.
	4	9	47	29 3	15	E 1	Fair.
		13	50	29 3	15	E 2	Dim reddish Sun-shine *.
		20	51	29 2	14		

* This unusual colour of the air, which, without a cloud appearing, made the sun-beams of a frange red dim light, was very remarkable. We had then heard nothing of the fire of *London*: but it appeared afterwards to be the smoke of *London* then burning, which, driven this way by an easterly wind, caused this odd phenomenon.

d	h	Th.	Bar.	Hy.	Wind.	Weather.
5	22	49	29 1			
6	9	44	29 2	15	N E 1	Fair.
8	9	44	29 4	15	N E 1	Fair.
9	9	46	29 4		S W 1	Thick, Sun.
	17	52	29 2	18	S 2	Rain.
	22	53	29 --	20	2	Rain.
10	9	52	28 8	20	S W 3	Fair.
	16	56	28 8	20	W 2	Rain.
11	11	53	28 8	22	S W 2	Cloudy.
12	9	52	29 --	23	S 3	Clofe.
13	9	50	29 2	23	W 2	Fair.
14	9	53	29 1	23	S E 2	Fair.
15	10	57	29 1	27	N E 1	Clofe.
	11	57	29 1	28	N E 1	Rain.
	23	61	29 1	35		Fair.
16	9	59	28 8	34	E --	Mist.
	21	61	28 7	37		Rain.

A Register kept by Mr. Locke in Oxford.

1666.
September

d	h	Th.	Bar.	Hy.	Wind.	Weather.
17	9	54	28 8	35	NW 1	Clofe.
	22	49	28 1	30		Rain.
18	9	42	28 8	37	NE 4	Clofe after Rain.
	11	43	29 1	36	EN 3	Clofe.
	13	44	29 2	35	EN 3	Clofe.
	17	45	29 3	35	E 2	Fair.
	23	45	29 4	35	o	Fair.
19	9	41	29 5	35	N 1	Fair.
20	9	46	29 4	37	N 1	Clofe.
21	8	47	29 3	36	o	Thick Mift.
	22	52	29 4	38	o	Fog.
22	10	84	29 4	37	SW 1	Clofe.
23	9	46	29 5	37	W o	Clouds.
24	8	49	29 4	38	SW 1	Fair.
	21	55	29 2	39	2	Fair, h. 19 few drops.
25	6	53	29 1	38	S 1	Clouds.
	10	54	28 8	39	S 3	Rain.
	21	50	29 1	38	o	Fair.
26	8	49	28 7	39	W 3	Clofe.
27	9	48	29 2	37	W 3	Fair.
	23	48	29 4	36	2	Fair.
28	7	45	29 5	36	W 2	Fair.
	19	47	29 4	37	2	Rain. 4 P 2

*The General History of the Air.*A Register kept by Mr. *Locke* in *Oxford*.

	d	h	Th.	Bar.	Hy.	Wind.	Weather.
1666.							
September	29	7	51	29 4	40	W N 1	Rain.
		12	53	29 5	38	W N 2	Fair.
		18	53	29 5	35	N W 0	Fair.
	30	9	48	29 6	37	W S 0	Clouds.
		21	57	29 5	46	2	Fair.
October	1	8	54	29 5	45	S 1	Clouds.
		19	61	29 5	43	0	Fair.
	2	9	56	29 5	44	S W 2	Clofe.
	3	7	54	29 5		S W 0	Clofe.
November	25	10	32	29 1			
	26	9	31	29 2		0	Thick Fog.
		18	31	29 1		0	Fog.
	27	11	33	29 1		W 0	Fair.
		18	34	29 2		0	Clouds.
		22	34	29 2		2	Clouds.
	28	10	39	28 7	63	S W 2	Rain.
		21	36	28 7	62	2	Fair.
	30	9	31	28 7	60	W S 2	Fair.
		22	31	29 1	61		Fair.
December	1	9	29	29 3	61	W 0	Fair.
		22	29	29 4	61	0	Fair.
	2	9	27	29 2	60	S E 2	Clouds, Thaw.
	3	9	27	28 7	60	E 1	Clouds.

A Register kept by Mr. *Locke* in *Oxford*.

1666.
December

d	h	Th.	Bar.	Hy.	Wind.	Weather.
	17	27	29 7	61	o	Rain.
4	9	26	28 8	60	SE o	Thick Fog.
	12	26	28 8	61	S 1	Snow.
5	9	30	28 6	63	S 1	Hard Rain.
	21	34	28 6	63	2	Fair.
6	9	34	29 1	64	W S 1	Fair.
	18	36	29 1	64	o	Small Rain.
7	9	32	29 3	63	W o	Fair.
8	9	32	29 3	65	W S 3	Small Rain.
	23	35	29 3	64	o	Rain hard.
9	9	31	29 1	63	N 2	Hard Snow.
	17	29	29 1	63	o	Fair.
10	21	26	29 5	63		Fair.
11	9	24	29 5	63	W N 1	Hard Frost, Fair.
	21	21	29 5	60	2	Fair.
12	9	20	29 6	59	N 1	Fair, hard Frost.
13	10	21	29 6	61	N 1	Fair, hard Frost.
14	9	22	29 6	63	N W 1	Little Mist, and slow Thaw.
	11	24	29 5	63	N W 2	Clouds, Thaw.
15	9	25	29 6	64	N 1	Fair, little Thaw.
16	9	24	29 6	63	N E o	Fog, hoar Frost.
	17	24	29 6	63	N E o	Thaw, Clouds.
17	9	22	29 6	63	N o	Clouds, hard Frost.

A Register kept by Mr. *Locke* in *Oxford*.

1666. December	d	h	Th.	Bar.	Hy.	Wind.	Weather.
		22	23	29 5	64		Thaw, Clouds.
	18	10	24	29 5	65	N 2	Small misty Rain.
		21	24	29 5	64		Small Rain.
	19	9	23	29 5	64	N W	Small Snow, Thaw.
	20	9	23	29 5	64	N 2	Mist, Thaw.
		22	22	29 5	64	0	Fair, freeze.
	21	10	20	29 3	63	S W 2	Hard Frost. Clouds.
		21	22	29 2	63	1	Snow.
	22	9	22	29 2	63	N W	Clouds, no Thaw.
		22	21	29 2	63		Frost, fair.
	23	8	21	29 1	64	N 0	Little Snow last Night, Frost, close.
		21	20	29 3	63	0	Fair, hard frost.
	24	10	17	29 4	62	N W 2	Fair, hard Frost.
		17	18	29 3	63	W 1	Snow.
	25	9	18	29 4	62	N W 1	Hard Frost, Fair.
		22	19	29 4	61		Fair, hard Frost.
	26	9	18	29 3	62	W 1	Fair, hard Frost.
		19	22	29 2	63	0	Clouds, Thaw.
	27	8	22	29 2	64	N W 1	Fog.
		16	22	29 2	63	N W 1	Close, Thaw.
		21	22	29 2	63	N W 0	Close, freeze.
	28	9	20	29 3	63	N W 0	Close, Frost.
		22	18	29 3	63	N W 0	Close, Frost.

A Register kept by Mr. *Locke* in *Oxford*.

	d	h	Th.	Bar.	Hy.	Wind.	Weather.
1666. <i>December</i>	29	10	16	29 4	63	N W o	Fog, hard Frost.
		22	15	29 5	62	o	Thick Fog, hard Frost.
	30	9	15	29 4	62	N W o	Very thick Fog, and hard Frost.
		22	15	29 4	62	N W o	Clear, hard Frost.
	31	8	14	29 4	62	N W o	Fair, hard Frost.
1667. <i>January</i>		15	15	29 5	63	N W o	Fair, hard Frost.
	1	8	12	29 4	62	N W o	Fog, hard Frost.
	2	10	13	29 6	63	S E o	Fair, hard Frost.
	3	9	10	29 5	63	S E o	Fair, hard Frost.
		22	11	29 3	63	o	Clofe, hard Frost.
	4	10	13	29 3	63	E S 1	Clofe, hard Frost.
	5	11	12	29 2	62	E o	Snow, Frost.
	6	9	13	28 8	3	E S o	Snow, Frost.
		15	14	28 7	63	E o	Clofe, Frost.
	7	9	16	28 6	64	E o	Clofe, hard Frost.
		17	18	28 6	64	E o	Little dewy rain, and tendency to a thaw.
	8	8	20	28 6	65	E N o	Clofe, Thaw, little Rain.
		21	21	28 8	64	o	Clofe, Thaw.
	9	8	21	29 2	65	E N o	Little Snow, and little Thaw.
		21	22	29 3	65	o	Clofe.
	10	9	21	29 3	65	N E o	Clofe, Frost.
		22	21	29 2	65	2	Clofe.
	11	8	20	29 2	65	N E 1	Clofe, Frost.

A Register kept by Mr. Locke in Oxford.

	d	h	Th.	Bar.	Hy.	Wind.	Weather.
1667. January		12	21	29 2	65	N E o	Clofe, gentle Thaw.
	12	9	21	29 2	64	N E o	Clofe, Frost.
	13	11	22	28 7	65	N E o	Thick Fog, Thaw.
		22	23	28 8	65	o	Clofe, great Thaw.
	14	8	24	28 7	65	E 1	Fog, perfect Thaw.
		21	24	28 6	65	2	Clofe.
	15	10	22	28 6	64	E N 2	Clofe, Frost.
		22	23	28 6	65	o	Small Rain.
	16	8	23	28 7	65	E S 1	Clofe.
	17	8	25	28 7	65	E N o	Fog.
	18	7	25	28 6	65	N E 2	Snow, Thaw.
		21	23	28 8	64	2	Little Snow.
	19	8	21	29 2	64	N E o	Frost, little Snow.
		22	20	29 4	64		Hard Frost.
	20	9	18	29 5	63	N o	Fair, hard Frost.
		22	20	29 6	63	o	Fair, Frost.
	21	8	18	29 6	63	N W o	Fair, hard Frost.
		17	21	29 6	63	W 1	Fair, Frost.
	22	9	25	29 5	66	S W 2	Rain.
		23	28	29 3	66	3	Rain.
	23	9	29	29 3	67	W S 1	Clouds.
		17	32	29 4	67	W 1	Fair.
	24	9	29	29 5	66	W S 1	Fair.

A Register kept by Mr. *Locke* in *Oxford*.

	d	h	Th.	Bar.	Hy.	Wind.	Weather.
1667. <i>January</i>		21	32	29 3	66	4	Clofe.
		23	33	29 2	66	4	Clofe.
	25	8	36	28 8	67	S W 3	Little misty Rain.
		19	42	28 6	73	3	Little misty Rain.
	26	8	38	28 8	72	W S 2	Clofe.
		12	37	28 8	73	W S 1	Rain.
	27	10	33	29 2	70	W S 2	Fair.
	28	22	30	29 2	69	1	Rain.
	29	6	30	29 2	70	1	Mift.
		16	31	29 3	70	N W 0	Clouds.
<i>February</i>	31	13	26	29 4	69	E 2	Clofe.
	1	9	26	29 5	69	E 2	Clofe.
	2	9	28	29 5	70	E 1	Clofe.
	3	9	31	29 5	72	S E 0	Thick Fog.
	4	9	33	29 4	72	E 0	Fog.
		22	34	29 6	73	0	Clofe.
	5	8	32	29 7	72	E 1	Clofe.
		22	31	29 7	71	2	Clofe.
	6	18	26	29 7	68	N E 1	Clouds.
	7	9	24	29 5	69	N E 1	Clouds, Snow in the Night.
		23	23	29 5	67	1	Clofe.
	8	10	22	29 5	67	E N 2	Frost, clofe.
	9	8	21	29 4	67	E S 1	Clofe, Frost.

The General History of the Air.

A Register kept by Mr. Locke in Oxford.

	d	h	Th.	Bar.	Hy.	Wind.	Weather.
1667. February		22	22	29 4	68		Snow.
	10	9	23	29 3	29	S E 1	Rain.
		16	28	29 3	71	S W 2	Mifty.
		23	32	29 2	73	2	Clofe.
	11	9	34	29 2	73	S W 2	Mifty.
		22	36	29 1	74		Clofe.
	12	8	35	28 7	74	S E 2	Clofe.
		22	37	28 4	73	2	Fair.
	13	8	34	28 4	72	S W 3	Fair.
		22	36	28 2	70	2	Clofe.
	14	8	34	28 4	69	W S 3	Fair.
		22	33	28 6	68		Fair.
	15	8	32	28 5	69	S 2	Rain.
		23	32	28 5	69	S 2	Fair.
	16	23	31	28 7	69	N 1	Clofe.
	17	9	30	28 8	69	W 1	Fog.
	18	11	32	29 4	66	N W 2	Fair.
	19	9	28	29 7	64	N W	Hoar Frost, fair.
		15	33	29 6	56	S 2	Fair.
	20	9	28	29 6	63		Fair.
	21	9	28	29 5	63	E S 1	Fair.
	22	8	29	29 5	62	N E 1	Clofe.
		15	29	29 5	60	N E 1	Rain.

A Register kept by Mr. Locke in Oxford.

	d	h	Th.	Bar.	Hy.	Wind.	Weather.
1667. ¹							
February	23	8	27	29 5	63	N E 2	Clofe.
	24	9	26	29 6	62	N E 2	Clofe.
	25	10	25	29 5	62	N E 1	Snow.
	26	7	23	29 4	61	N E 1	Frost, little Snow.
	27	8	23	29 2	61	N E 1	Clofe, Frost.
	28	9	21	29 1	60	N E 1	Fair, Frost.
March	1	11	22	29 2	59	E 1	Fair, hard Frost.
	2	10	23	29 3	60	N E 1	Clouds, Frost.
	17		26	29 3	59	N E 1	Hail.
	3	9	24	29 4	60	N E 2	Clofe.
		21	25	29 4	62	2	Mifty, Rain.
	4	9	25	29 4	60	N E 2	Clofe.
	5	9	24	29 2	60	N W 2	Clofe, about 6 small Snow.
	6	23	17	29 4	56	2	Fair, hard Frost.
	7	9	15	29 4	55	N E 2	Fair, very hard Frost.
		13	16	29 4	54	N E 2	Snow.
	8	8	14	29 2	54	N E 2	Very hard Frost, Thames frozen, Carts went over.
	9	8	18	28 8	58	N E 2	Snow hard, already deep, hard Frost.
	10	9	18	29 2	58	N E 2	Clofe, hard Frost.
	11	8	19	29 3	57	N E 1	Hard Frost, little Snow.
	12	8	21	29 5	57	E N 1	Frost.
	13	9	21	29 5	56	N E 1	Clofe, Frost.
	14	8	21	29 4	56	S E 2	Clofe, Frost.
						4 Q 2	

*The General History of the Air.*A Register kept by Mr. *Locke* in *Oxford*.

	d	h	Th.	Bar.	Hy.	Wind.	Weather.
1667. <i>March</i>	14	16	23	29 3	55	S E	Clofe, Thaw.
	15	8	23	29 2	57	E 1	Mift, Thaw.
	16	8	27	29 1	59	S E 2	Rain.
		21	30	29 0	60	0	Fair.
	17	11	31	29 2	60	N E 1	Clofe.
	18	8	28	29 6	61	N E 1	Fair.
		18	35	29 6	62	S 1	Fair.
	19	8	33	29 6	61	S W 1	Clofe.
	20	6	37	29 6	61	W 1	Fair.
	21	10	35	29 4	55	S W 2	Small Rain.
		12	36	29 4	56	S W 2	Small Rain.
		23	38	29 1	59	3	Clofe.
	22	9	37	29 1	58	W 2	Fair.
	23	9	35	29 1	58	S E 1	Clouds.
		11	36	29 1	58	S E 1	Rain.
	24	9	35	29 2	58	N W 1	Clouds.
	26	7	30	29 5	50	N W 1	Fair.
	27	7	29	29 6	49	N E 1	Fair.
	28	9	28	29 5	48	N E 1	Fair.

I began to keep a register of heat and cold at *London*; by a thermometer of the Royal Society's standard: this thermometer I marked 2.

	d	h	T. 2.	Bar.	Hy.	Wind.	Weather.
1669. <i>December</i>			0				
	26	9	3				Extreme hard Frost.
1670. <i>January</i>	13	10	4				

A Register kept by Mr. *Locke* in *London*.

	d	h	T. 2.	Bar.	Hy.	Wind.	Weather.
1670. <i>January</i>	13	23	4				Clofe.
	14	10	4				Clofe.
		22	4				Mixt, <i>i. e.</i> part Clouds, part clear.
	15	23	3				
	16	10	2				Fair.
	17	10	2				Fair.
	18	9	2				Mift.
	19	10	1				Mift.
	20	1	0				Clouds:
		9	0				Clofe, Frost.
	21	9	1				Clofe.
	22	23	1				Fair.
	23	9	1				Fair.
	24	9	1				Fair.
	25	9	1				Clofe.
	26	8	0				Snow.
	27	10	0				Snow.
	28	10	0				Snow.
	29	23	0				Hard Frost.
	30	11	0				Hard Frost.
	31	11	0				Thaw.
<i>February</i>	2	11	0				Frost.
	3	10	0				Frost.

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A Register kept by Mr. Locke in London.

	d	h	T. 2.	Bar.	Hy.	Wind.	Weather.
1670. February	6	23	0				
	7	9	0				Snow.
	8	9	0				Fair.
	9	10	0				Fair.
	10	9	1				Clofe.
	11	10	0				Fair.
	12	10	1				Thaw.
	13	9	1				Rain.
	14	9	0				Fair, Frost.
	17	23	3				Mist.
	20	11	2				Fair.
April	1	10	1				Clofe.

I here divide the degrees of the *Gresham College* thermometer, each into 4, so that 24 is now the same that 6 was before.

	d	h	T. 2.	Bar.	Hy.	Wind.	Weather.
May	27	9	24				Fair.
	29	11	31				Fair.
		23	24				Fair.
	30	7	22				Fair.
		23	29				Fair.
June 1671.	1	9	28				Cloudy.
May	29	8	20				Rain.
June 1672.	5	8	31				Cloudy.
January.	31	9	4			N E.	Fair.

The General History of the Air.

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A Register kept by Mr. Locke in London.

	d	h	Th.	Bar.	Hy.	Wind.	Weather.
1672.							
February	1	8	0- 5				Fair.
June	15	16	36-				Cloudy.
	16	9	33				Cloudy.
		17	37			S W 2	Fair.
	20	9	29				Cloudy.
August	15	6	24				
	17	8	25				Clofe.
October	13	9	20				
December	23	22	20				
	27	17	18				
1673.							
January	1	22	18				
	4	18	14				
April	3	17	5				Snow.
May	10	21	16			E	
June	9	22	22			E	Rain.
	10	9	21				Cloudy.
	12	9	23				Fair.
	13	22	22				Rain.
	14	9	24				Clofe.
	17	9	26				
	18	9	26				Clofe.
	20	9	22				Fair.
	21	9	24				Fair.

The General History of the Air.

A Register kept by Mr. Locke in London.

	d	h	T. 2.	Bar.	Hy.	Wind.	Weather.
1673. June	22	6	23				Fair.
	27	10	26				
	28	9	25				Rain.
Memorand. That from the beginning of <i>May</i> , till the end of <i>July</i> , there was scarce one dry day, but so great rains, that produced greater floods than were known in the memory of man.							
	d	h	T. 2.	Bar.	Hy.	Wind.	Weather.
July	2	9	25				
	8	10	26				
	10	8	25				Fair.
	14	17	31				Fair.
	25	22	35				
	28	12	33				Clofe.
	30	9	24				Fair.
1674. March	9	8	1			N E	Frost and Snow.
	19	6	5				Snow.
	20	10	5			E N	Snow all day.
December	25	15	11				Fair.
	27	16	11			W	Fair.
	28	15	14			W	Clofe.
1675. January	3	16	14			W	Fair.
April	25	9	12			N E	Fair.
	26	10	12			N	Fair.
	27	12	12			E	Fair.
	28	9	12			E	Clofe.

A Register kept by Mr. Locke in London.

	d	h	T. 2.	Bar.	Hy.	Wind.	Weather.
1675. May	2	9	16				Clofe.
	23	15	27				Cloudy.
June	8	22	21				Cloudy.
	9	13	21				Clofe.
	10	14	22				Clofe.
	13	10	22			E	Clofe.
	14	9	17				Rain.

The thermometer marked 3 is one which I began now to use at my return to Oxford.

	d	h	T. 3.	Bar.	Hy.	Wind.	Weather.
1681. March	14	14	46	29 4		W 2	A little Mist.
	15	8	36	29 6		N W	Fair.
	16	12	45	29 5		N W 2	Little Rain.
	17	7	37	29 7		E	Fog.
	18	8	33	29 7		E	Fair.
	23	11	34	28 8		N W	Clofe.
	24	12	32	29 2		N	Cloudy.
	25	18	33	28 7		N W	Cloudy.
	26	15	32	8		N	Cloudy.
	27	13	28	29 2		N	Fair, Snow this Morning.
		14		29 2		N	Snow hard.
	28	11	29	5		N	Cloudy.
	30	7	34	5		W	Clofe. All the foregoing Week it rained in Showers every Day.
April	6	18	49	4		S	Very fair.

A Register kept by Mr. Locke in Oxford.

	d	h	T. 3.	Bar.	Hy.	Wind.	Weather.
1681. <i>April</i>	7	9	45	5		S	Very fair.
		17	55	4		S W	Very fair.
	9	8	50	3		S W	Clofe.
		14	50	2		S W	Rain.
	10	11	44	3		W 2	Clouds, and a little shower this morning.
	11	17	46	5		S W 2	Fair ever since yesterday.
	12	15	51	2		S 3	Fair since.
	13	14	49	3		W 2	Fair since.
	14	13	45	3		S W 3	Fair since.
	15	17	54	3		E N	Clofe all day.
	16	8	45	3		E N 1	Mift.
		17	52	2		E N 1	A little shower between 4 and 5.
	17	6	49	2		N E 1	Thick Fog, Showers between 6 and 7 last night.
	18	7	46	2		S W 2	Fair, and Clouds since.
<i>May</i>	3	14	50	29 4		N E 2	Clofe, no rain since <i>April</i> 18, but very hot and fair weather till yesterday, the wind for the most part between N. and E.
	4	10	44	4		N E 1	Clofe since.
	5	8	37	4		N E 1	Clouds.
	6	8	37	2		E N 1	Fair, clouds yesterday.
		19	46	29		W 1	Cloudy.
	7	7	41	28 8		W N 2	Clouds.
		11	43	8		W 1	Rain.
		16	47	7		W 1	Clofe.

A Register kept by Mr. Locke in Oxford.

	d	h	T. 3.	Bar.	Hy.	Wind.	Weather.
1681. May	8	9	41	29		N E 1	Cloudy since.
	9	9	42	2		E N 1	Fair.
	10	4	47	3		N 1	Fair since.
	11	9	48	3		S E 1	Fair since.
		15	61	2		S W 1	Fair since.
	16	11	54	6		S W 1	Fair, a little shower or two since.
		18	65	5		W 1	Fair since.
	17	8	55	6		N W 1	Fair since.
	19	17	70	2		N E 1	Fair since.
	20	6	6	64	3	N E 2	Cloudy, no rain from hence till June 20, the driest spring that hath been known, there having been no rain from the end of March to the end of June.
August	2	6	65	3	7	N W 1	Fair.
	3	11	60	3	8	N 1	Fair.
	4	9	62	3	9	W 1	Fair.
	5	9	62	3	8	E 1	Fair.
	6	15	71	1		S 1	Fair.
	7	9	68	2	9	S 1	Fair.
		15	72	28 8	8	S W 2	Cloudy.
	8	8	68	7	9	S 2	Clofe.
		11	69	7	9	S 2	Rain a little.
	9	9	64	8	10	S W 1	Clofe.
		17	66	7	10	S 1	Rain a hard shower.
	10	6	62	7	11	S W 2	Clofe.

A Register kept by Mr. Locke in Oxford.

	d	h	T. 3.	Bar.	Hy.	Wind.	Weather.
1681. <i>August</i>	11	9	62	29 1	11	S W 1	Clofe.
	12	8	66	2	17	S W 1	Mift.
	13	9	69	28 8	18	S 1	Rain.
		14	72	7	17	S W 1	Fair, Clouds.
	14	8	67	8	17	S 1	Fair.
		16	72	6	16	S E 1	Thunder Shower.
	16	9	69	29 2	17	S W 1	Rain for $\frac{1}{3}$ hour, and then fair.
	17	6	69	2	16		
	18	4	67	3	16		
1682. <i>February</i>	10	12	25	29 5		E N 1	Clofe, Frost.
	11	10	24	29 6		N E 1	Fair, Ice.
	12	15	27	29 7		N E	Very fair.
	13	11	24	29 7	61	N E 1	Thick Fog.
	14	8	23	29 6	63	N E 1	Fair.
	15	8	29	29 5	65	E N 1	Clofe.
	17	8	31	29 0	72	S 2	Cloudy, and some Rain.
	20	17	42	28 7	75	S E 2	Rain.
	21	8	44	28 6	75	S 2	Rainy.
	22	9	42	28 7	77	S 2	Clofe.
	24	10	41	29 2	74	S E 1	Clofe.
	25	15	39	28 7	75	N E 1	Rain ever since yesterday in the afternoon.
	26	10	38	29 1	74	N 1	Clofe.
	27	7	37	29 3	75	N W 1	Clofe.

A Register kept by Mr. Locke in Oxford.

	d	h	T. 3.	Bar.	Hy.	Wind.	Weather.
1682.							
February	28	10	39	29 4	73	W 1	Clofe.
March	1	9	42	29 3	74		Fog.
	5	16	30	29 1	67	S 1	Very fair, hard frost in the morning.
	6	10	28	29 2	67	N E 1	Fair.
	7	11	25	29 2	65	N 2	Very fair.
	22	13	29	29 2	57	N 3	Cloudy, and a little Snow.
	23	8	25	29 4	56	N 2	Clofe, Frost.
	24	7	29	29 4	57	W 1	Clofe.
	25	9	36	29 2	59	N 2	Clouds.
	26	8	31	29 4	56	N 1	Clofe.
	27	8	34	29 4	57	W 2	Fair.
		13	39	29 3	59	W N 1	A Shower.
	28	7	35	29 4	56	N W 1	Fair.
	29	7	30	29 5	50	N	Clouds.
	30	8	30	29 5	48	N E 2	Fair.
		11	31	29 5	47	N E 3	Snow.
	31	8	30	29 6	48	N E 2	Fair.
April	1	8	30	29 6	49	N E 2	Clofe.
	2	9	33	29 6	50	N E 1	Clofe.
		19	36	29 6	51	N E 1	Small Mist.
	3	7	34	29 6	51	N E 1	Small Mist.
	4	9	34	29 6	50	N E 1	Clofe.
	5	7	34	29 5	50	N E 1	Fog, and Sun-shine.

A Register kept by Mr. Locke in Oxford.

1682. April	d	h	T. 3.	Bar.	Hy.	Wind.	Weather.
	6	9	39	29 4	49	N 1	Fair.
	7	9	39	29 5	48	N 1	Fair.
	8	8	39	29 5	44	S E 2	Fog and sun-shine.
		11	43	29 5	44	S E 2	Fair.
	9	7	40	29 3	40	S E 2	Thick Fog.
		14	41	29 1	41	S 2	Rain.
		20	43	28 7	44	S 2	Rain till past 6, now fair.
	10	7	43	28 6	47	S W 2	Clofe, rain in showers most part of the day
	11	8	43	28 6	49	S W 2	Clofe, rain in showers most part of the day
	12	7	41	28 5	48	S W 1	Clofe, shower about noon.
		16	44	28 6	47	W N 1	Fair.
	13	6	37	28 8	47	S E 1	Fair.
		17	44	28 5	47		2 Rain.
	14	7	42	28 2	48	S E 2	Rain all the morning till past 12.
		14	45	28 5	50	W 3	Rain, more or less, almost all the afternoon
	15	6	40	29 1	50	S W 2	Fair.
	16	7	43	29 1	48		Fair, hard shower about 18.
	17	7	47	28 8	49	S E 1	Clofe, showers several times in the day.
	18	7	43	28 7	50	S E 1	Rain the greatest part of the day.
	19	6	44	28 7	52	S 2	Clofe, rain a great part of the day.
	20	6	44	28 6	51	S E 1	Rain, and so in showers several times of the day.
	21	4	45	28 6	51	S 1	Cloudy, rain most part of the morning.
	22	8	47	28 7	51	S 1	Rain.

A Register kept by Mr. Locke in Oxford.

	d	h	T. 3.	Bar.	Hy.	Wind.	Weather.
1682. April		17	51	28 8	52	N 1	Rain, most part of the afternoon.
	23	7	46	29 2	52	N 1	Clofe.
		13	49	29 3	52	S 1	Clofe, rain almost all the afternoon.
		22	49	29 3	52	N about 18	Hard rain.
	24	6	46	29 4	52	E 1	Clofe, hard rain at night.
	25	7	47	29 1	52	E S 1	Clofe, some rain.
		14	42	28 8	53	S E 1	Dropping.
		22	54	28 7	54		3 Hard rain from 18.
	26	7	52	28 6	54	S 2	Cloudy, rain often in the day.
	27	5	52	28 8	55	S W 1	Clofe, a good deal of rain before night.
	28	18	51	28	55	S W 1	Clofe, rain a good part of the morning, and some in the afternoon.
	29	8	47	29 1	55	S W 1	Cloudy, a little rain in the afternoon.
	30	5	47	28 8	55	S W 1	Fair.
		18	46	28 6	55	N E 1	Hard rain, which began about 11, and lasted till 21 or 22.
May	1	4	42	28 8	55	N W 2	Cloudy.
		21	47	29 2	54	N W 1	Fair.
	2	8	43	29 2	54	S W 1	Cloudy, hard rain from 19 or 20 all night.
	3	6	49	28 7	54	S W 2	Clouds, wind W. all the afternoon, but fair, bating a little rain in the evening.
	4	5	52	28 7	54	S E 1	Rain hard till 13.
		13	54	28 7	53	N 1	Rain hard till night.

Memorand. That new fitting my barometer, here the mercury was raised by addition of more in the receiver about $\frac{2}{18}$ inch, which is almost 2 of my degrees, which are eights; though I suspect it is still, by reason of included air, a degree or two too low.

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1682.	d	h	T. 3.	Bar.	Hy.	Wind.	Weather.
May	4	22	53	29 2	54		Small rain.
	5	8	48	29 3	54	E 1	Rain.
		20	51	29 3	55	E 1	Clofe rain most part of the morn. and 2 or 3 showers in aftern.
	6	7	48	29 3	55	N E 1	Mist.
	7	8	46	29 4	55	E 2	Rain a great part of the day.
	8	4	53	29 2	56	S W 2	Hard rain till 7 or 8.
	9	10	54	29 1	55	E 1	Clofe.
		14	55	29 1	55	S W 1	Rain.
	10	9	50	29 2	54	S 1	Cloudy, a little rain about 17, and again about 22.
	11	6	49	28 2	54	S W 1	Clofe.
		9	50	29 2	55	S W 1	Short shower, several short showers in the aftern.
	12	6	49	29 3	54	S W 1	Clofe, a shower in the morning.
	13	4	51	29 2	53	E 1	Clofe, several showers in the day.
	14	9	53	29 4	54	S W 2	Clouds.
	15	7	51	29 4	51	S 1	Fair.
	16	8	61	29 2	48	S E 1	Fair, hard shower about 18.
	17	5	60	29 3	48	S W 2	Clofe.
	18	7	57	29 5	47	W 1	Fair.
	19	8	58	29 5	45	W S 1	Fair.
	20	5	63	29 3	43	S E 1	Fair.
		16	69	29 3	43	W S 1	Very fair.
	21	8	59	29 3	44	S 1	Fair.
	22	9	69	29 1	42	S E 1	Fair.

A Register kept by Mr. *Locke* in *Oxford*.

	d	h	T. 3.	Bar.	Hy.	Wind.	Weather.
1682. <i>May</i>		17	47	29 1	38	S W 2	Fair.
	23	7	64	29 2	38	W 1	Fair, gentle rain from 8 to 11.
		10	63	29 2	38	W 1	Rain.
	24	7	62	29 2	39	N 1	Clofe.
	25	6	59	29 3	42	N W 1	Fair.
	27	9	53	29 5	42	W 1	Fair.
	28	14	67	29 3	33	S 1	Fair.
<i>October.</i>	14	9	45	29 6	49	W 1	Clofe, rain laft night.
	16	13	48	29 4	51	S W 2	Rain till bed-time.
	17	9	47	29 2	51	W 1	Fair, little rain.
	18	10	41	29 1	51	S W 2	Cloudy, hard rain from 5 to bed-time.
	19	9	39	28 7	51	W 1	Fair, fhower in the afternoon.
	20	9	34	28 7	51	o	Rain.
	27	22	38	29 7	60		Clofe.
	28	10	37	29 7	60	E N 2	Fair,
<i>November</i>	8	18		29 8			Fair, hard froft.
	9	9	22	29 8	57	N 1	Fog, gone before noon; hard froft.
	10	10	26	29 8	58	E N 1	Fair, hard froft.
	11	9	25	29 7	56	N E 1	Clofe, hard froft.
	12						Fair, hard froft.
	13	10	26	29 5	57	N E 1	Clofe, hard froft.
	14	13	23	29 7	57		Thick fog, fair in the afternoon.
	15	10	36	29 4	56	S W 1	Clofe, rain this morning, hard rain 22.

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	d	h	Th.	Bar.	Hy.	Wind.	Weather.
1682.							
November	16	5	41	29 1	66		Hard rain, rain most part of the day.
	17		41	29 1	65	S W 1	Rain.
	17	11	39	29 1	64	W S 2	Fair.
	18	9	37	28 7	64	o	Fog, rain most part of the day.
	19	9	33	29 1	62	W 1	Fair, rain in the night.
	20	10	40	29 1	64	W N 1	Fair, rain in the afternoon.
	22		42	29 2	63	2	Fair.
	21	6	42	29 1	64		Hard rain till 10.
	16		43	29 2	64	W 2	Fair.
	22	11	33	29 5	63	W 1	Small fog, frost this morning.
	23	9	28	29 5	62	N W	Fog, thick fog all day.
	24	9	25	29 5	62	N W	Thick fog, little rain in the evening.
	25	8	35	29 3	67	S W 1	Clofe, rain in the evening.
	26	9	35	29 4	65	W N 1	Fair.
	27	10	31	29 7	64	W N 1	Fair.
	28	4	32	29 8	65		Fair.
	29	8	33	29 7	65	W S	Small fog.
	30	9	35	29 7	65	S W 1	Fair.
December	1	8	35	29 6	66	S 1	Mist.
	2	9	34	29 6	66	S 1	Clofe.
	3	9	34	29 6	66	S W 1	Foggy.
1683.							
June	21	9	62	29 3	46	W 1	Clofe.
	22	8	65	29 2	48	W S 2	Clofe, some showers.

A Register kept by Mr. Locke in Oxford.

	d	h	T. 3.	Bar.	Hy.	Wind.	Weather.
1683. June	23	7	59	29 4	46	W 1	Cloudy.
	25	19	67	29 4	44	W N 1	Fair, mist in the morning.
	26	10	64	29 5	43	S 1	Very fair.
		17	72	29 3	43	S W 2	Fair.
	30	13	62	29 3	37	W N 3	Fair.

An Explication of the foregoing Register.

THE first column with *d.* at the top, contains the day of the month.

THE second column, with *h.* at the top, contains the hour of the day, which beginning from midnight, I count to 24, which is midnight again; so that 13 stands for one afternoon, and so on.

THE third column, with *Tb.* at the top, marks the degrees of my thermoscope, which having been blown up at a lamp, though the spaces of the degrees were equally divided, yet because of the unequal bigness of the small tube, towards the extremities, where it grew bigger, it did not always in every degree mark equally proportionable degrees of heat and cold. The points to be observed in that and the next column, which is that for the baroscope, shew the just place, where the top of the tinged spirit of wine in the one, and the mercury in the other, stood between the line of the degree marked, and the following, when the observation was made. The thermoscope I made use of till *December*, 1669, was a sealed one, with all the degrees increasing with the heat in one continued series. The thermoscope, which I used from *December* 1669, to *June* 1675, and is marked 2, was one of Mr. *Cotgrave's* adjusting, which beginning the reckoning from the temper of freezing, hath the numbers increasing both upwards and downwards; the points shew it to be in the degrees, above 0, if set over, and under 0, if set under: and . . . or . . . shew it higher or lower in each degree. The thermoscope used from *March* 1681, to the end, is marked 3, and is of the kind of that used first.

THE column having *Hy.* at the top, contains the degrees of moisture, as marked by an hygroscope made of the beard of a wild oat.

IN the column of the wind, I not having the convenience to observe the points exactly, have marked but 8, but yet with this variety, that where I set two letters, the wind was most from that point whose letter stands first, *v. g.* W. N. signifies more west than north. When I set only one letter, it was in or very near that cardinal point.

THE strength is marked by 0, 1, 2, 3, 4. 0 signifies not so much wind, that moved any leaf that I could see in a garden I looked into out of my window, but the letter joined to it signifies which way the weather-cock then stood, whether the former wind left it so, or the present breeze blew that way. 1 signifies a gentle gale,

just perceivable by the moving of the leaves or plants. 4 signifies a very violent storm: 2 and 3 the several degrees between 1 and 4, as well as I could judge. These degrees, though not so exactly measured as I could have wished, I yet thought better than nothing.

B

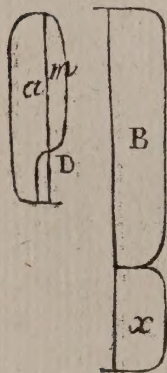
LE tuyau recourbé estoit fermé au bout *a* et ouvert à l'autre extremité B. la recourbure depuis G. jusq' à C. estoit pleine de mercure, & tout le reste estoit plein d'air. La longueur *Æ*. C. estoit 4 pouces ou $\frac{2}{3}$. J'echauffay cet air, et il fait baisser le mercure jusques en f. qui estoit $\frac{3}{8}$ plus bas, & en mesme temps il monta jusq' en H. qui estoit $\frac{5}{8}$ plus haut que G. ou C.

Pour sçavoir quelle hauteur de mercure auroit este necessaire pour empescher la dilatation de l'air, & retenir le mercure en C. je n'ay que trouver ce qui seroit necessaire pour repousser le mercure en C. et ainsi contenir l'air dans l'espace *Æ* C. non obstant la chaleur. Je pose pour principe ce que l'experience fait voir, c'est que quand une quantité d'air occupe un certain espace que j'appelle. *Æ*. et que la pression qui le retient dans cet espace soit B. si on vient à augmenter cette pression de telle quantité que l'on voudra comme X. on diminuera l'espace *Æ*. d'une certain quantité. D. laquelle quantité est au restant. M. comme X. est à B.

$$D : M :: X : B.$$

donc

$$M : D :: B : X.$$



Il est aisé d'appliquer cette reigle à l'experience cydessus; car *Æ*. f. ou $\frac{3}{8}$ de ponce sont l'espace *Æ*. La pression ordinaire de l'air, qui est de 30 ponces jointe *a* un ponce de haut que se trouve entre f. et H. est B X. 31 ponces de mercure: et si nous y en adjoustons assez pour reduire l'air à l'espace. *Æ*. C. le dit. *Æ*. C. sera M. X. $\frac{3}{8}$ et. f C. sera D X. $\frac{3}{8}$.

Posant donc. M. D. . B.

$$32. 3. 31.$$

La quatriesme proportionnelle sera X, X. 2 $\frac{2}{3}$ ponces, qui estants joints à B X. 31 ponces feront 33 $\frac{2}{3}$ ponces, dont l'air sera pressé en C *Æ*. qui sont pres de 4 ponces au dessus de la pression ordinaire.

Experiment made at the Spire of the cathedral Church in Sarum, by colonel John Windham, assisted by Mr. Thomas Nash, clerk of the Works, and John Warner, in November, 1684.

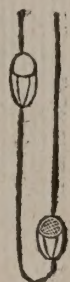
HAVING gotten together all the surveying chains the city afforded, and carefully examined their truth, and having prepared a proper frame for the baroscope, we went into the church, filled the tube, and with all the nicety we could use purged it of the airy particles; and then immersing it as in the Torricellian experiment, the mercury was there suspended 30 inches, and 50 cents of an inch, measuring it from the surface of the stagnum: then drawing it up to the first floor above the vaulting, which is 1033 inches and $\frac{1}{2}$ high from the pavement, the mercury subsided 9 cents of an inch: from thence drawing it up to the middle floor, which is 935 inches higher, the mercury subsided 8 cents lower than before: and from thence drawing it up to the weather-door, which is 2313 inches higher than the last, the mercury subsided 23 cents below its station. So the whole height it was drawn up is 4281 inches and a half; and the whole difference of the mercury's standing is 40

cents

cents of an inch. And letting it down the same way, the mercury reascended to its first stations.

At another time with an inverted baroscope, like the figure in the margin, having made a mark, where the liquor stood, when it was below in the church, and drawing it up to the first floor over the

Vaulting	Which is above the pavement of the church	$\left\{ \begin{array}{l} 1033 \text{ and } \frac{1}{2} \\ 1968. \\ 2467. \\ 4281. \\ 4800, \text{ or } 400 \text{ feet.} \end{array} \right\}$	The liquor ascended	$\left\{ \begin{array}{l} 1 \ 25 \\ 2 \ 39 \\ 3 \ 22 \\ 5 \ 64 \\ 6 \ 40 \end{array} \right\}$
To the middle floor				
To the 8 doors floor				
To the weather-door				
To the top				



If your honour desires to have any other experiments made at the spire, Mr. *Nash*, whom I have mentioned above, is a person well skilled in the practical parts of mathematicks, and a great lover of learning, but more especially natural and experimental philosophy, having all of your honour's philosophical works. This person I know would most gladly and heartily embrace any opportunity of serving your honour, whensoever you will be pleased to let me impart any thing to him in a letter.

This is humbly advertised by, Sir,

Your honour's most obliged,

and most obedient servant,

24 Decembris 172.
Anno 1685.

JOHN WARNER.

At a place in the great continent in *Europe*, but not far from the ocean, a learned acquaintance of mine keeping a baroscope some years, and being discoursed with by me about the difference of the phaenomena, that may be expected in places situate upon the continent, from what we find in this country, as it is an island: he related to me, that a few years since, casting his eyes upon the baroscope in ordinary weather, and that was calm enough, he was surpris'd to see the mercury so strangely rais'd, as to exceed above two inches its wonted station, which great alteration he found within few hours to have been the forerunner of so hideous a storm, as was generally wondred at, and did a great deal of mischief both in the towns and country of those parts, where it left sad instances of its fury. This wind came all along the continent; but my relator divers times observed, that when very boisterous winds blew from the sea, and the storms came thence, (which lying to the southward) the mercury in the baroscope would considerably subside, as has likewise been observed here in *England* by an ingenious gentleman, living within less than two leagues of the sea, to whom I presented a baroscope to make observations with.

An industrious young man, that, whilst he was my domestic, I bred up to chemistry, (of which he now teaches courses) relating to me the other day, that toward the latter end of the last month (which was *June*) being at *Oxford*, where his house is, he had occasion to cast his eyes upon his baroscope, and was not a little surpris'd to find, that the quicksilver was in an extraordinary measure altered from the height it stood at but a while before: whereupon, though the weather were very hot and fair, as is usual in *June*, and had continued so for some days, yet he took upon him

to

to foretel from this great and quick subsidence of the mercury, that there would be before long some notable change of weather. And accordingly it happened within about four or five hours, that the sky was all overcast; and there fell a hideous storm of rain, lightning, thunder, and accompanied with such a whirlwind, as scarce any remember to have seen in that city.

A Letter to the Author.

HONOURED SIR,

I HAVE been able to do so little in the attempts I have made to serve you, that I am ashamed to have been so well furnished to so small purpose. The barometer I had from you was conveyed safe into the country, and as soon as it came to my hands, I rode to *Minedeep*, with an intention to make use of it there in one of the deepest gruffs (for so they call their pits) I could find: the deepest I could hear of was about 30 fathom, but the descent so far either from easy, safe, or perpendicular, that I was discouraged from venturing on it. They do not, as in wells, sink their pits strait down, but as the cranies of the rocks give them the easiest passage; neither are they let down by a rope, but taking the rope under their arm, by setting their hands and legs against the sides of the narrow passage, clamber up and down, which is not very easy for one not used to it, and almost impossible to carry down the barometer, both the hands being employed. This information I should have suspected to have come from their fear, had not an intelligent gentleman, neighbour to the hill, assured me it was their usual way of getting up and down. For the sight of the engine, and my desire of going down into some of their gruffs, gave them terrible apprehensions; and I could not persuade them but that I had some design: so that I and a gentleman, that bore me company, had a pleasant scene, whilst their fear to be undermined by us made them disbelieve all we told them; and do what we could, they would think us craftier fellows than we were. But, Sir, I will not trouble you with the particulars of this adventure: but certain it is the women too were alarmed, and think us still either projectors or conjurers. Since I could not get down into their gruffs, I made it my business to enquire what I could concerning them: the workmen could give me very little account of any thing, but what profit made them seek after; they could apprehend no other minerals but lead ore, and believed the earth held nothing else worth seeking for: besides, they were not forward to be too communicative to one they thought they had reason to be afraid of. But at my return, calling at a gentleman's house, who lives under *Minedeep* hills, and who had sent out his son to invite me in; amongst other things he told me this, that sometimes the damps catch them, and then, if they cannot get out soon enough, they fall into a swoon, and die in it, if they are not speedily got out; and as soon as they have them above ground, they dig a hole in the earth, and there put in their faces, and cover them close up with turfs; and this is the surest remedy they have yet found to recover them. In deep pits they convey down air by the side of the gruff, in a little passage from the top; and that the air may circulate the better, they set up some turfs on the lee side of the hole, to catch, and so force down the fresh air: but if these turfs be removed to the windy side, or laid close over the mouth of the hole, those below find it immediately by want of breath, indisposition, and fainting: and if they chance to have any sweet flowers with them, they do not only lose their pleasant smell immediately, but stink as bad as carrion. Notwithstanding this ill success, I had attempted some trials once more, had not the spreading of the contagion made it less safe to venture abroad, and

hastened me out of the country sooner than I intended. But I have some hopes, the next journey I make into those parts, to give you a better account than this that follows. Near the house, where I sometimes abode, was a pretty steep and high hill. *April 3. hora inter 8 & 9. matutin.* the wind west, and pretty high, the day warm, the mercury was at 29 inches and $\frac{1}{4}$, being carried up to the top of the hill, it fell to 28 inches $\frac{3}{4}$, (or thereabouts, for I think it was a little above 28 inches $\frac{3}{4}$;) both going up and coming down, I observed, that proportionably as I was higher or lower on the hill, the mercury fell or rose. At my return to the bottom of the hill, the mercury wanted of ascending to its former height $\frac{1}{32}$ of inch, which I impute to the sun's rarifying some particles of air, that remained in the upper part of the tube, rather than to any other change in the air; for I find it harder to clear the tube of the air perfectly, than at first I thought, or of water, if that have been put in with the mercury, and I fear liable to the same inconvenience with air inclosed. I know this is far short of what you might have expected, and has, I fear, but little answered your desires, since I guess it was the perpendicular height of the place I made the experiment in, that you would have had, and perhaps other considerations of air, inclosed, and liable to mineral steams, would have made a trial in one of the gruffs more acceptable to you. I do not think any thing in this letter worthy of you, or fit for the public. But since I find by the two last Philosophical Transactions, that observations on the Torricellian experiment are much looked after, and desired to be compared; if for want of better, this should be thought fit to fill an empty space in the philosophical news-book, I shall desire to have my name concealed. But I fear, that this very caution of being in print, where there is no danger of it, has too much of vanity in it. I am sure it is boldness enough, though allayed with obedience, to venture such slight things to your sight. I visited the incrusted spring I formerly mentioned to you, and could not find any thing incrusted within at least 20 yards of the rise of it. The place, where it works most, is about 40 or 50 yards from the spring head, and is at a fall higher than my head: there it sheaths every thing with stony cases, and makes the sides of the bank hard rock, and from thence all along its stream it covers sticks, &c. with a crust; and some so candied I found above this fall, but not so frequent; whether the mixing of air with the water in the fall contributes any thing to the effect, I cannot guess; but that the fall does, I suppose: for besides, that at the above-mentioned fall it seems to operate most strongly, I observed, that though I could not find any thing incrusted within a good distance of the spring, yet that the moss above the spring was a little incrusted, (but not so firmly as at the other place) for the water in the winter, when the springs are full, runs out also at a hole two or three yards above the place, where now only it rises, and from thence falls perpendicularly into this lower spring, from whence it runs by an easy descent to the next fall. A gentleman, in whose field it rises, and by whose house it runs, told me upon enquiry, that he uses it both in his kitchen and brewhouse, without any sensible ill effects, he being a pretty ancient, but healthy man, and long inhabitant of that place. It will bear soap, freezes quickly, and waters his grounds upon occasion, with advantage. All the ill effects of it, that he can guess, are, that his horses are usually short-breathed, which he imputes to the drinking of that water. I brought with me from *Minedeep* some ore, and some stones; but I think them so inconsiderable, that I shall not judge them worth sending, unless you please to command them. I am, Sir,

Your most humble, and

most obedient servant

Cl. Cl. 5^o May,
1666.

J O H N L O C K E.

P O S T S C R I P T.

I HAD forgot to mention to you, that in their gruffs, after burning, (when they meet with hard rocks in their way, they make a fire upon them, that they may dig through the easier) they find it very dangerous to go down into them, as long as there remains any fire or heat in any chinks of the rocks.

SOME days ago the king doing me the honour to discourse with me about the use of baroscopes, was pleased to say, among other remarkable things, that at a time his majesty then named, he went from *Whitehall* about six in the morning, towards the mouth of the river, attended by divers of the nobility, and particularly by one lord then present, whom his majesty put in mind of the adventure; and then he added, that though the weather were exceeding fair, and likely to continue so, insomuch that some of the courtiers congratulated to his majesty so promising a morning; yet when they were once gone too far to return, he told them he thought they would be much mistaken, and that they were to prepare for a storm; which conjecture his majesty grounded upon his having, unknown to the company, consulted a good baroscope before he went out, and found the mercury in it to have suddenly, and very notably subsided. And accordingly within a very few hours the event verified his majesty's prediction, a sudden storm driving on the yatch he was in for divers leagues, at a very unusual rate.

Nous apprenons de ces experiences, que puisque le poids de l'air et le poids de l'eau, qui est dans les pompes, se tiennent mutuellement en equilibrio, ils pesent precisement autant l'un que l'autre; Et qu'ainsi en connoissant la hauteur, ou l'eau s'eleve en tous les lieux du monde, nous connoissons en mesme temps, combien chacun de ces lieux est presse par le poids de l'air, qui est au dessus d'eux; et partant.

Que les lieux, qui sont au bord de la mer, sont pressez par le poids de l'air, qui est au dessus d'eux jusques au haut de sa sphere, autant precisement, que si au lieu de cet air on substituoit une colomme d'eau de la hauteur de 31 pieds deux poulces.

Ceux, qui sont plus elevez de dix toises, autant que s'ils portoient de l'eau de la hauteur de 31 pieds un poulce.

Ceux, qui sont elevez au dessus de la mer de 500 toises, autant que s'ils portoient de l'eau à la hauteur de 26 pieds onze poulces: Et ainsi du reste.

Nous apprenons par ces experiences, que l'air, qui est sur le niveau de la mer, pese autant que l'eau, à la hauteur de 31 pieds deux poulces; mais parce que l'air pese moins sur les lieux plus elevez que sur le niveau de la mer; et qu'ainsi il ne pese pas sur tous les points de la terre egalement, Et mesme qu'il pese differemment par tout, on ne peut pas prendre un pied fixe, qui marque combien tous les lieux du monde sont chargez par l'air, le fort portant le foible; mais on peut en prendre un par conjecture bien approchant du juste; comme par exemple, on peut faire estat, que tous les lieux de la terre en general, confiderez comme s'ils estoient egalement chargez d'air, le fort portant le foible, en sont autant pressez, que s'ils portoient de l'eau à la hauteur de 31 pieds; et il est certain, qu'il n'y a pas un demy pied d'eau d'erreur en cette supposition.

Or nous avons veu, que l'air, qui est au dessus des montagnes hautes de 500 toises sur le niveau de la mer, pese autant que l'eau à la hauteur de 26 pieds 11 poulces.

Et par consequent tout l'air, qui s'étend de puis le niveau de la mer jusqu' au haut des montagnes, hautes de 500 toises, pese autant que l'eau à la hauteur de 4 pieds un poulce, qui estant à peu près la septième partie de la hauteur entiere; il est visible, que l'air com-
pris

compris depuis la mer jusques à ces montagnes est à peu pres la septième partie de la masse entiere de l'air.

Nous apprenons de ces mesmes experiences, que les vapeurs, qui sont épaisses dans l'air, lors qu'il en est le plus chargé, pesent autant que l'eau à la hauteur d'un pied huit poulces; puisque pour les contrepeser elles font bouffer l'eau dans les pompes à cette hauteur, par dessus celle, ou l'eau contrepesoit déjà la pesanteur de l'air: de sorte que si toutes les vapeurs, qui sont sur une contrée, estoient reduites en eau, comme il arrive, quand elles se changent en pluie, elles ne pourroient produire que cette hauteur d'un pied huit poulces d'eau sur cette contrée. Et s'il arrive par fois des orages, ou l'eau de la pluie qui tombe vienne à une plus grande hauteur; c'est parce que le vent y porte les vapeurs des contrées voisines.

Nous voyons aussi de là, que si toute la sphere de l'air estoit pressée & comprimée contre la terre par une force, qui la poussant par le haut, la reduisist en bas à la moindre place qu'elle puisse occuper, & qu'elle la reduisist comme en l'eau, elle auroit alors la hauteur de 31 pieds seulement.

Et par consequent, qu'il faut considerer toute la masse de l'air en l'estat libre ou elle est, de la mesme sorte, que si elle eust esté autrefois comme une masse d'eau de 31 pieds de haut à l'entour de toute la terre, qui eust esté rarefiée et dilatée extremement, et convertie en cet estat, ou nous l'appellons air, auquel elle occupe à la verite plus de place, mais auquel elle conserve precisement le mesme poids, que l'eau à 31 pieds de haut.

Et comme il n'y auroit rien de plus aisé, que de supputer, combien l'eau, qui environneroit toute la terre à 31 pieds de haut peseroit de livres; et qu'un enfant, qui scait l'addition et la soustraction le pourroit faire; on trouveroit par le mesme moyen, combien tout l'air de la nature pese de livres, puisque c'est la mesme chose; et si on en fait l'épreuve, on trouvera, qu'il pese à peu près huit millions de millions de millions de livres.

J'ay voulu avoir ce plaisir, et j'en ay fait le compte en cette sorte.

J'ay supposé, que le diametre d'un cercle est à sa circonference, comme 7 à 22.

J'ay supposé, que le diametre d'une sphere estant multiplié par la circonference de son grand cercle, le produit est le contenu de la superficie spherique.

Nous sçavons, qu'on a divisé le tour de la terre en 360 degrez: cette division a esté volontaire, car on l'eust divisée en plus ou moins, si on eust voulu, aussi bien que les cercles celestes.

On a trouvé, que chacun de ces degrez contient 50,000 toises.

Les lieues autour de Paris sont de 2500 toises; et par consequent il y a 20 lieues au degre: d'autres en comptent 25; mais aussi ils ne mettent que 2000 toises à la lieue; ce qui revient à la mesme chose.

Chaque toise à 6 pieds.

Un pied cube d'eau pese 72 livres.

Cela posé, il est bien aisé de faire la supputation, qu'on cherche.

Car puisque la terre a pour son grand cercle, ou pour sa circonference
360 degrez.

Elle a par consequent tour de 7200 lieues.

Et par la proportion de la circonference au diametre aura 2291 lieues.

Donc en multipliant le diametre de la terre par la circonference de son grand cercle; ou trouvera, qu'elle a en toute sa superficie spherique 1649200 lieues quarrées.

C'est à dire 103, 095, 000, 000, 000, toises quarr.

C'est à dire 3711, 420, 000, 000, 000, pieds quarr.

Et parce qu'un pied cube d'eau pese 72 livres:

Il s'ensuit, qu'un prisme d'eau d'un pied quarré de base, et de 31 pieds de haut, pese 2232 livres.

Donc si la terre estoit couverte d'eau jusques à la hauteur de 31 pieds, il y auroit autant de prismes d'eau de 31 pieds de haut, qu'elle à de pieds quarréz en toute sa surface. (Je scay bien, que ce ne seroient pas des prismes, mais des secteurs de sphere; et je neglige exprés cette precision.)

Et partant elle porteroit autant de 2232 livres d'eau, qu'elle à de pieds quarréz en toute sa surface.

Donc cette masse d'eau entiere peseroit,

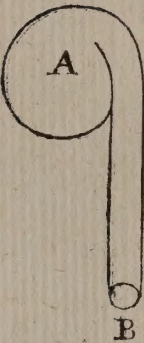
8283, 889, 440, 000, 000, 000, livres.

Donc toute la masse entiere de la sphere de l'air, qui est au monde, pese mesme poids de

8283, 889, 440, 000, 000, 000, livres.

C'est à dire, huit millions de millions de millions, deux cent quatre vingt trois mille huit cent quatre vingt neuf millions de millions, quatre cent quarante mille millions de livres.

Mr. Pascal, in his small Tract, either *De la Pesanteur de l'air*; or in that *De l'Equilibre des liqueurs*.



De cætero, feci haud ita pridem experimentum ponderandi aeris, quod pulchrè successit; nam sumptâ vitreâ lagenâ, valde levi et ad lampadem sufflatâ, ejus figuræ, qualem hic excusam vides, magnitudine parvæ pilæ, quales habentur in sphæristeriis, non habente nisi minimam quandam aperturam, per quam immittatur pilus in extremitate orificii sui B. ponderavi eam in balance valde exacta, & frigida pondus habuit 78 granorum cum dimidio: postea calefeci eam carbonibus impositam, & reposui in balancem eo situ, quo hic descriptum vides, nimirum orificio in imum verso, & deprehendi eam vix habere pondus 78 granorum, tam immergendo orificium in aquam, refrigerescere feci, & dum aer se condensat pro modo, quo refrigerescit lagena, intravit tantundem aquæ, quantum aeris calor antea expulerat; denique ponderans eam cum omni illa aqua deprehendi eam habere pondus 72 granorum & dimidii plus quam antea: unde concludo aerem, qui per ignem expulsus erat, se habere ad aquam, quæ in locum suum regressa erat uti $\frac{1}{2}$ se habet ad $72\frac{1}{2}$, aut uti se habet 1. ad 145. sed potui in eo errasse; difficile quippe est in ea re omnino exactum esse; id saltem certò scio, quòd pondus aeris hoc modo sit sensibile, & prolixè hic deduxi processum meum, ut si te eadem curiositas incessat, possis id eodem modo perficere experimentum. Vale.

T I T L E XVIII.

Of the Consistency of the Air, its Rarity, Density, Fluidity, Subtily.

A THIN but large bladder, wherein there was about the third part of the air it was capable of containing, being strongly tied at the neck, and at the opposite part suspended and clogged at the bottom, with a weight of 14 pound; so that it rested on the floor, which sustained it; the strings, that tied the bladder, were well stretched before, and could not shrink a quarter of an inch without drawing up the weight. Then two fire-shovels, with small coals and ashes were applied at a convenient distance, and kept moving to warm and rarify the included air, without cracking the bladder; by which means, after some of the wrinkles of the bladder had been displayed, not without noise, the air being expanded, and consequently the bladder a little swelled, and the whole string shortened, the weight was raised and made to swing.

swing like a pendulum. The same experiment being tried two or three times with a quarter of an hundred, succeeded not, though with large bladders, the heat still either breaking the bladder with noise, or occasioning some little leak, which hindered the desired success; though once we came so very near it, that it is scarce to be doubted, that if we had had good accommodations, it would have succeeded well, and that perhaps if the weight had been greater.

To try whether the corpuscles of the air would dive into a liquor, that was exposed but to the ordinary pressure of the free air or atmosphere; we covered the bottom of a cylindrical vial with filings of copper, and then poured on it an urinous spirit, to the height of about three fingers breadth; and on this liquor we poured oil of almonds to the thickness of a crown piece of silver, or that of about the fifth part of an inch; then we stopped the vial well, and left it in a quiet place for several days. The event was such as we expected, namely, that the urinous liquor did then first acquire, and then lose a blue tincture, both were done but slowly. And when the colour was pretty well lost, (for the liquor was not clear, but somewhat troubled) we took out the cork, and kept the vial unstopped for one minute of an hour, and then stopped it again, that in that short time the upper part of the urinous spirit began to be tinged with blue, and within an hour, though the vessel were all the while kept stopped, the sky-colour reached to the lower part of the liquor, which at this time is wholly and deeply of that colour, the oil that swims above it being clear.

T I T L E XIX.

Of the Heat and Coldness of the Air.

THOUGH the peripatetick doctrine about the limits and temperaments of the three regions, into which they divide the air, hath been so plausibly proposed, that it has been readily entertained, not only by the Aristotelian schools, but by the generality of philosophers, as well modern as ancient: yet since I think it becomes a naturalist to consider, not so much how easy a doctrine is, by reason of its concinnity, to be remembered or supposed, as how strongly it is to be proved, I must not dissemble, that as to this vulgar theory, I think it fitter we should wish it to be true, than that we should believe it is so: for I confess, that upon the best informations I have been able to procure from travellers by land and sea, or from writers, that relate rather what they have observed, than what they have been taught, I have been much tempted to question the received doctrine of the schools about the regions of the air. And that you may judge, whether or no my thoughts be rational, the ensuing discourse shall acquaint you with several of the particulars on which they are grounded.

WHAT I have in other papers written concerning cold, does not only make it less proper for me to treat of it indefinitely in this place, but would make it difficult for me to say much on this subject without repetition. And it were perhaps fittest for me to say nothing on an occasion, wherein I have left myself little to say, that is new and pertinent; but yet since this title promises not any thing about cold in general, but only some less heeded particulars relating to the coldness of the air; that I may not leave it wholly unfurnished, I will refer to it a few instances that ensue.

THE physician elsewhere mentioned, that was lately at *Morocco*, answered me, that notwithstanding the excessive heat reigned there in the day time, he felt the night very cold, and so he did the mountainous air in those parts.

AN intelligent gentleman, that stayed a year in *Guinea*, and spent part of that

time in the land, answered me, that notwithstanding the excessive heat of the climate, he was divers times, about four of the clock in the morning, reduced to be ready to tremble for cold, as he lay in his hammock, for about an hour together.

A LEARNED man, that lived at *Jamaica*, assured me, that when he laid in his hammock, about three or four foot from the ground, though he had much clothes under him, and little or none over him, he felt it cold beneath, and hot above.

It is obvious to every man's sense or observation, that the greater heat, that is usually found in our air, during the summer, than in other seasons of the year, has manifest effects upon such easily agitable bodies as liquors, and upon the juices and flesh of animals, and the softer parts of vegetables. But that even in places sheltered from the sun-beams, the warmth of a temperate summer should be able sensibly to rarify and expand so cold and compact a body, as glass itself, would not be easily suspected or believed. And yet, that this is one of the effects of the temperature of the air in summer, seems very probable by this experiment, that having two large fictitious crystal vials, I caused some stopples of the same matter to be exquisitely ground, and fitted, this or that vessel exactly closed, when the stopple was in it, was very easy to be opened in winter, and in the colder parts of the neighbouring seasons; but in summer it was oftentimes so difficult to unstop the same vessel, that a man's force, though assisted with a string, was not able to pull out the stopple: so that I was often reduced to cause the necks of the vials to be held under a pump, or to be stirred to and fro in a vessel full of water, that the coldness of that liquor might take off the expansion, that the heat of the season had given the glass, which being by this means made to shrink into its former dimensions, the vial and stopple would be easily enough disjoined. This was tried in several vessels, and in more than one more year. But to make this experiment successful, the two parts must at first have been exquisitely adjusted to one another, which in those glasses, with stopples of the same matter, that are commonly sold, they are not usually found to be.

We are wont to attribute the effects we feel of the summer's heat, to the bare warmth of the air, and to the agitations, that such warmth produces in the parts of our bodies, especially in the blood, juices, and spirits; whereas it may very well happen, that we may find odd changes in ourselves, upon very hot weather, which proceed not from the heat of the air as such, but rather from this cause, that by such a degree of heat, divers bodies, that we think not of, may be solicited to send forth effluvia, that have emitted none before, or at least no such quantity as could make them sensibly operative. And these effluvia may be the true and immediate causes of divers effects, that are unwarily ascribed to the mere heat of the air, and that, which it produces in our bodies. To illustrate and confirm this conjecture, I shall propose the following experiment.

BEING in the heat of summer in the country, I took a somewhat large piece of fine amber, that I usually employed about electrical experiments; and when the sun had reached a considerable height above the horizon, I placed it in a shaded part of a window, on which he shined freely: though I left the amber here for a competent time, yet I could not find, that it would draw a piece of straw, feather, or other light body, that at a convenient distance was held to it. But when I removed it a very little farther into a part of the window, into which the sun-beams fell freely, they quickly put its parts into such an agitation, as made it emit electrical effluvia, and readily attract those light bodies, that would not stir before, and which it would soon, though not immediately, lose the power of drawing, as before, if it were removed back into the neighbouring shaded part of the window.

MAY 26. Mr. *Nickson*, who was four years governor of the English colony in

Hudson's bay, answered me, that when they sailed within a certain distance of floating islands of ice, if the wind blew from thence toward the ship, or, as the seamen speak, if they were to the leeward of the ice, they could by the new and sensible cold they felt, know, that such ice lay to windward of them, sometimes even before they were able to discover it by sight. And when I farther asked, at what distance that might be, he answered, that it was sometimes twelve or fifteen miles, if not twenty. He added, that usually, when the wind blew from those great masses of congealed water, it brought along with it a foggy air, which he supposed to come (as well as the cold) from the ice.

THE same gentleman answered me, that in that part of *Hudson's bay*, wherein he wintered, the rivers began to freeze about the latter end of *October*, or beginning of *November*, and usually were not free from ice till about the middle or latter end of *May*, though he divers times took the latitude of *Charleton* island, the place most frequented by the English, and seated at the bottom of the bay, and found it to be near the same with that of *London*, and at most but about 52 degrees.

WHEN I enquired about the depth of the ice in the rivers, he answered, that they had often occasion to observe it; for in the winter they made their wells there, (not in the ground) and were obliged to dig about six foot deep in the ice, before they could come at unfrozen water.

HE answered me, that when they sent their men up into the country, their bottles of brandy would oftentimes so freeze, that about a fourth part of it would be turned into ice. And when I asked, whether the unfrozen part of the liquor was not exceeding strong, he answered me, that it was, and sometimes so much so, as to be too fiery and unpleasant to the taste.

HE answered me, that he always found the ice fresh, that floated upon the sea-water; and that when they wanted fresh water, or had a mind to spare what they had aboard, they often supplied themselves out of the cavities of great floating masses of ice; in which hollow places the sun-beams thawing some parts of the ice, they frequently found store of liquor, that was produced by the action of the sun-beams upon the superior parts of the ice, whence the water ran into these cavities. He added, that when the seamen were in haste, they used to relieve themselves by cutting or breaking off pieces of the floating ice, and presently melting it in their pots.

A LEARNED traveller, that made some considerable stay among the high Pyrenean mountains, answered me, amongst other notable things, about which I made enquiry, that he had several times observed at the top of one or other of those tall hills, that the air would be very hot, and that yet the same day, and perhaps within very few hours, the place would be covered with snow, though it were then summer time.

DOCTOR N. answered me, that the winds he felt at *Morocco* were so very hot, that they were ready to stifle him, seeming to him like the steams and smoke coming out of the mouth of an oven.

THE Russian emperor's physician confirmed to me, that at *Archangel* (where he was more than once) they averred to him, that in winter time a northerly wind (which comes from the sea) produces a kind of thaw, so as to make the eves drop, though a north-east wind rather confirms the frost; but on the contrary, a southerly wind which, blows over a thousand or a hundred miles of frozen land, does rather increase the frost, than bring the thaw.

A VERY inquisitive person, that visited the lofty Pyrenean mountains, answered me, that he and his company had more than once observed, from the top or higher part

part of one of those hills, that though it were fair weather there, yet a great way beneath them, the hill was surrounded with thick clouds, which produced storms of rain on the lower grounds: and that (which was the chief point I enquired after) they could manifestly see, that out of those clouds, when it thundered, lightnings flashed upward as well as they are generally observed to do it downward.

OCTOBER 19. Doctor *Stubbs* assured me, that having at *Jamaica* taken a bolt-head about two foot and a half in length, he usually found, that betwixt 7 and 8 in the morning, which they there call the faint time (of the day) because for want of the daily breezes, the excessive heat makes them to faint away; the water was wont to rise in the neck but a quarter of an inch and a half, though at that time, by reason of the winds, men found the heat very supportable: and after noon was past, the water would subside by degrees till towards the above mentioned time the next morning. This happened in a south window, where the fresh winds came fully and freely in to beat upon the bolt-head, without any glass to screen the vessel from the wind.

He added, that though the bolt-head were not stopped, yet the water did not even in that hot country decrease sensibly in eight or ten months.

A HEEDFUL person, that frequented the coast of *Sumatra* in the *South-Sea*, answered me, that he never observed ice or frost, or snow, in that great island, but that he had known hail fall even in that torrid climate.

THOUGH the famous island of *Ceylon* lyes almost in the midst of the torrid zone, namely, between the 6th and 10th degrees of northern latitude, yet an observing man, that lived many years upon it, told me, that in hills not so high, but that we might easily ascend to the top in half an hour, the inequality of the air's temperature, as to heat and cold, was very great: for he had divers times observed in himself and others, that though at the bottom of the hill the heat was so great, as to oblige them to go almost stark naked, yet when they ascended the hill, they found the air quite altered; and as they went up higher and higher, the cold increased upon them; so that notwithstanding the heat, so uneasy a motion as climbing had given them, the coldness of the air obliged them to put on unusually warm clothes, and at the top of the hill they would for all that be ready to quake for cold.

CAPTAIN *Knox* answered me, that in 18 years, that he spent in the island of *Ceylon*, he never observed any ice or snow, nor any more than a little kind of meteor, that was between dew and hoar frost, which sometimes in winter mornings appeared very oddly, but quickly vanished. And when I asked, if he had not seen hail itself, he answered, that he never saw it but once, but the inhabitants looked upon it as a wonderful thing, unseen by them before; that the hail was as large as a black cherry, but not very round, and seemed to have the corners melted, which made him think it had been formed high in the air; that for fear of mistaking, he not only gathered some of it, but champed it between his teeth, and found it cold and hard, like our European hail; and that he was fain to be nimble in making his trials, because when the hail came to touch the ground, it would melt away much more suddenly than one would have expected,

GREGORY being asked, upon a very sultry day, whether it were not very hot in *Germany*, made answer, to day has been something hot; such is the winter in *Suaquena*. *Ludolf. hist. of Ethiop. L. I. c. 5.*

*Ludolph.
hist. of
Ethiop. L.
I. c. 5.*

THE heat of the island *Suaquena*, Gregory used to call infernal: for, says he, it ex-coriates the skin, melts hard Indian wax in a cabinet, and sears your shoes like a red hot iron.

THE

THE higher you ascend the mountains of *Ethiopia* from the coast of the *Red Sea*, the more temperate you shall feel the air, inasmuch that, as *Tellezius* witnesses, in many regions of *Ethiopia* the summer heats are more mild than in *Portugal*, so many degrees distant towards the north; nay, there are some mountainous countries, as in *Samen*, where the cold is more dreadful than the heat. Nevertheless there falls none, or very little snow in these parts, only a certain small sort of hail sometimes covers the ground, which at a distance looks like snow.

Ludolp.
hist. of
Ethiop. L.
I. c. 5.

AN intelligent person, that was for many years consul of the English Nation at *Tri-poli* in *Barbary*, being asked some questions about the air, and the winds in those parts, answered me, that when in summer time the wind blew over the great sandy deserts, that reach very far into the country, the wind, and the sand it brought along with it, oftentimes felt as hot as the steams, that come out of an oven, when the mouth is opened, inasmuch, that he could not, without great inconvenience, turn his face towards the quarter whence the wind blew.

AN ingenious gentleman, that was employed in the French colony, on the coast of *Afric*, and lived in those parts about five years, answered me, that in the island of *St. Louis*, or near it, at a certain season of the year, when the hot winds blew from the continent, the sand on the shores would be so scorching hot, that he was not able to stand upon it, but it would, through the soles of his shoes, scorch his feet, unless he walked very fast. And then the air seemed to him to be thick, and, as he expressed it, heavy and hot, as if it came out of an oven. And when the wind blew from a wood, where divers elephants and other wild beasts lay dead, the steams of their carcases would make the air so stinking and offensive, that it was scarce supportable.

In summo ejus montis, Idæ sc. fastigio sacellum est, quod ædificiolo duntaxat constat saxis sibi invicem impositis, & sine calce cohererentibus, formicis in modum constructo, ad tectum præbendum. Sublimi adeo loco est, & à vehementioribus ventis interdum ita perflato, ut lapilli inde transferantur. Paulo infra id sacellum planities conspicitur montibus undique cincta, in quâ multa sunt pascua, ubi arietes & capræ Cretenses æstate pinguescunt. Si quis ex summo montis vertice undique prospiciat, parum aberit, quin totius insulæ ambitum videat cum aliis vicinis insulis, Miso, Cerigo, sive Cythera reliquisque Archipelagi. Aeris intemperies in hoc monte adeo magna est, quemadmodum ut in cæteris præcelsis montibus, ut in ipsis caniculæ ardoribus meridie, nullo etiam spirante vento, ingens sentiat frigus: qua de causa nec hyeme, nec æstate quisquam eum incolit. Nam licet pastores interdum ovium greges ad pascua agunt, noctu tamen in valles se recipiunt.

Petri Bello-
nii, Lib. I.
cap. 1.

In the next chapter.

Latè porro patet hic mons, ejusque radices utrinque maris littora, ut ante diximus, attingunt; nam licet urbi *Candiæ* sunt vicinæ, meditullium tamen insulæ occupat ipse mons, adeo in sublimi erectus, ut nives ejus verticem perpetuo tegant; tamque frigida aura mediis etiam æstatis ardoribus isthic est, ut vix ferri queat; tamen in convallibus magnus sit æstus.

Contigit id meæ experientiæ, quod etiam aliis contigisse audiui, ut ascenderem ad summitatem usque montis *Veneris*, qui omnium in *Patarino* agro altissimus est, ibi per totum diem habui aerem serenissimum, sed infra circiter medium montis vidi nubes, quæ me visione vallium prohibebant, vespere autem, postquam de illo monte descendi, inveni factam eo die infera parte magnam pluviam, cum in montis cacumine nihil pluisset; ex eo intellexi me transisse per mediam aeris regionem, in qua est facta pluvia, nec tamen eam sensi frigidissimam, imò vix aliquam animadverti differentiam frigidioris & calidioris aeris, nam æstivum tempus erat, pro æstivo tempore eram vestitus, nec tamen tantum frigoris, quod me læderet, ex eo loco percepi; pars igitur illa non est absolutè frigida, sed solùm comparatione inferi aeris calidioris.

Jacobi
Zabarelli
de regionibus
aeris, c. 8.

Idem de Alpihus proprio exemplo edoctus testatum reliquit Bartholinus Syst. Phys. Instit. Succinēt. de Terra, Aere, & Igne, c. 4. Resp. 1.

DOCTOR B. answered me, that being at and near *Morocco*, he could see mount *Atlas* covered with snow, though it was then in the heat of summer, and excessively hot where he was.

AN intelligent traveller, that had visited some high mountains, and particularly the *Alpes*, and the *Pico* of *Teneriffe*, answered me concerning this prodigious hill, that he found it very cold in ascending towards the top; and that as for the mount *Cenis*, one of the famousst of the *Alpes*, when he passed over it into *Italy*, though it were in *August*, and the weather very clear, yet he felt at the top a wind so cold, that he could scarce possibly endure it, and seemed to him the coldest, that in all his various travels he had ever felt; and yet some of the mountains seemed much higher being then covered with snow.

AN intelligent gentleman, that had been a traveller into the *East-Indies*, told me, that he never saw nor heard of any snow or ice in *Guinea*, but that in some parts of *Barbary*, where in the plains and vallies he found the heat scorch insupportable, he could see the top of the mountains covered with snow, in which state they continued all the year.

A MAN of letters, that lived in many countries of the *East-Indies*, being asked by me divers questions, partly about other things, and partly about the temperature of the air in several regions, gave me, among other answers, this, that on the high mountain in the island of *Ceylon*, notwithstanding the heat of the country, there was snow; and the like he saw on the tops of the mountains of *Congo*, though in the lower parts of the country they never have, that he heard of, either ice, snow, or hail.

ABOUT Midsummer, 1688, I placed in the cave a glass, with spirits, which stood above temperate about $\frac{1}{2}$ of one of the small divisions: another glass placed without, in a common room, stood at hot.

THE Christmas following I placed the same glasses in the same places, and the glass in the cave stood, as before, about temperate; that without stood at frost.

THE cave is cut into the bottom of a clift, that fronts to the sea: the earth is about 80 foot above it, and it is cut right in about 120 foot.

THE other day two gentlemen belonging to the province of *New-Hampshire* in *New-England*, (whence they came not long since) and employed by that colony to his majesty here, answered me, that in the winter the coldest wind, that blows in the country, is the north-west; and being asked again, what was their hottest wind in summer, they told me, it was likewise the north-west. At which answer being surprized, I asked them, whether they could give any reason of so odd a phænomenon. Whereto they answered, that they ascribed it to the large tract of the continent, and the great woods that lay to the north-west; which woods, they said, in the winter had their branches, through which the wind past, all laden with snow: and in the summer, they said, the close air of the vallies, and the thick steams, that filled it, would conceive so intense an heat, that sometimes in the heat of summer, when a sudden puff of wind blew upon their faces from those sultry vales, it seemed to them, as if it came out of the mouth of a furnace, and would be ready to overcome them with the faintness produced by the heat and vapours it brought along with it.

Balbini
hist. Bo-
hem. L. 1.
c. 9. De
montibus,

*De montibus ad Bavariam stantibus mira est Alberti Chanovii nostri narratio: post Bergreichensteinam (oppidum fodinis hodieque nobile) esse montes non tam situ (alii enim ad septentrionem, alii ad meridiem latus obvertunt) quam caelo & temporibus adversantes, val-
libus*

libus latissimis montes illos dirimentibus; monstri instar est (quod se vidisse, & anno 1639. in rem præsentem venisse religiosissimus ille & apostolicus vir asserit) in altero monte sæpius æstatem, in altero appposito hiemem dominari, ita ille siccus æstivat, hic altissimis nivibus obsitus à viatore superari non potest; ob eamque causam messes ipsæ variant, & dum in montibus ad nos obversis demessa sunt omnia, altera montium parte seges virescit: mirius illud, quod in Bieffinensibus & Czachroviensibus agris in tractatu Pisenensi, contiguis, quos unus tantum sulcus dirimit ac dividit, deprehenditur: Czachrovienses adhuc hibernant, cum in Bieffinensi cælum ardeat; ibi caput attollit humo frumentum, cum Czachrovii adolescit in culmum; elemento quoque dispari, illud riget, hoc tepet & fervet, eaque ex causâ, dum Czachrovienses bene pellii ingrediuntur, Bieffinenses pellibus onerari se sentiunt, villosque deponunt. Aliquid tale anno 1652. mihi quoque accidisse memini: nam cum Glacio Zambergam in Bohemia contenderem, & Glacio ob nives altissimas certum vehiculi genus, quod trabas dicimus, sumpsissem, superatis montibus, qui comitatum Glacensem à Bohemia dividunt, subito alia rerum facies apparuit: altero enim montium latere viridia omnia reperimus, sic ut trabæ nulli jam rei & ufui essent, & currum petere cogeremur, nisi in luto natare placuisset; at accolæ montium illorum quotannis id sibi accidere confirmabant, ut unum latus montium profundissimæ nives contegerent, quando alterum latus lætissimos flores proferret, & cum ibi omnia ventis verti viderentur, apud se è floribus suavissimos odores efflari.

& de valle
Lauzka,
p. 29.
Cbanowski
in vestigio
Bob. pie,
c. ult.
Montes
parte alte-
râ æstatem,
alterâ hie-
mem refe-
rentes.
Id. ibid.

I LEARNED, by enquiry of an ingenious gentleman, who several times went into the Hungarian gold-mine at Cremnitz, that when he was drawn up out of the deep pit, or perpendicular groove, whose depth exceeded 100 feet; when he had ascended above half the way, he found the air sensibly warm, and so it continued, till he came by many foot nearer the day, as the workmen call the orifice of the pit. And when I asked, whether this notable and sudden heat did not proceed from some mineral, through which he passed in that region of the earth, or part of the groove, he answered me, that he believed it did, in regard he was there surrounded with a vein or bed of native vitriol, some of one colour, some of another, which he found to be soft under ground, though it soon after hardened in the air: and of these differinglly coloured sorts of vitriol he brought up thence several pieces, some of which he presented me. And when I asked, whether the new heat he found in that part of the mine, did not proceed from its being much nearer than the lower part to the air, which at that time was hot; and whether he found the heat to increase as he came nearer the day; he answered in the negative, and told me, that after he had in his ascent left beneath him that warm region, he found himself cold again in the superior part of the groove, to which the vitriolate region did not reach.

I REMEMBER on this occasion, that asking an intelligent person, who had more than once crossed the torrid zone, what expedient they used in his ship, to keep their beer and other liquors cool enough to be drinkable in those sultry climates; he answered, that their way was to take the bottle they mean to use, and wrap it about with a coarse linen cloth dipped in the sea-water, and then in some more convenient place of the ship hang it in the wind, which beating freely and incessantly upon it, would in no long time cool it to be potable enough. And this gentleman, who was an observing person, added farther, that having sometimes for curiosity sake taken away a bottle before it had been exposed above half the usual time, he was able to find by the taste, that part of the beer or wine, that was next the sides of the bottle to be refrigerated, whilst the more inward parts of the liquor did yet continue hot.

THE Czar's chief physician confirmed to me, that in the year 1664, or 63, extraordinary dry and great scopes of land were set on fire, and miserably wasted by the great heat of the sun. And he added, that the very last year he found the like to

have happened in *Norway*, particularly in a place called by us *Bear-baven*; where having seen the ruin of divers wood houses burnt, and enquiring into the cause, he was answered, that the weather being very dry and hot, not only the grafs and other vegetables were scorched up, but those wooden houses among others were set on fire, which was confirmed to him by the governor of the place, and countenanced by this circumstance, that he saw the country covered with a fresh and verdant livery of new grafs, brought up instead of that which was burnt, by some rains, that fell a while before.

A TRAVELLER and scholar being asked by me, whether at *Mozambique*, which is thought the hottest place in the known world, he had never observed the houses to be set on fire with the mere heat of the sun? he answered me, that in the three months he stayed there, he saw no such thing, but the inhabitants affirmed it to be not very unfrequent; and as he passed to and fro, shewed him divers houses that had been so burnt; which was the less strange, because the houses are not built of ordinary stone, whereof they have none there, but fetched from another place he named, where the stone is mingled with a substance, much of the nature of a sulphur vivum. And he added, that he himself had divers times seen the stones so heated in hollow places, that musket-bullets being exposed there to the direct beams of the sun, were in no very long time melted. He said farther, that much of the excessive heat of *Mozambique* proceeded from the soil, which is exceeding bare and dry, consisting of white sand, and that it is not covered with grafs, nor shaded with trees.

AN observing traveller, that had been at *Mozambique*, being for the most part, where it is not shaded with trees, sandy, he found the sun, which was almost in the zenith, to heat the ground so much, that he was not able to stand still for some time, but was fain to keep walking to avoid burning the soles of his feet.

Un gentilhomme de mes amis plein de merite et digne de creance me mande, entre plusieurs choses extraordinaires, qu'il a observées proche de Barege aux Pyrenées, qu'il y a des ponts de neige d'un rocher à l'autre par-dessous lesquelles passent des torrents. Il en a vu un, qui embresse deux torrents, et qui a vint neuf toises de long et autant de large par dessus. Il y a par dessous ce pont neuf toises et demi entre les naissances de la voute, les ponts sont tellement forts, qu'il estime que du canon y passeroit, et il a fait rouler de grosses pieces par dessus.

Le tremblement de terre, que souffrit la Syrie l'an 750. ne fut gueres moins surprenant; puisque la terre s'estant ouverte de toutes partes, plusieurs villes furent abîmées, d'autres renversées, et quelques unes, qui estoient élevées sur des hauteurs, transportées dans des plaines éloignées de six mille de leur situation. On en peut dire autant du froid extreme, qui l'an 753 glaça le Pont-Euxin à la longueur de cent mille, et toute l'estendue de la mer voisine, jusqu'à 30 coudées de profondeur, quoy qu'on ne fût encore qu'au commencement de l'automne. Journal de Sçavans III. 1685.

ASKING an intelligent person, that lived a good while in *Guinea*, how they did to keep their water cool in so hot a place, he told me, that in some corner of their huts they were wont to make holes in the ground, in which they buried over night the long earthen jars, or other vessels, so as that the orifice of the vessels might be lower (though not very much so) than the level of the ground. By this means the water would become drinkable, with some coolness, from the beginning of the morning to nine or ten of the clock, after which it would grow distastefully hot. He added, that when they were abroad in the fields, he did as well cool his water, by putting it into callibashes, and hanging them all night upon the branches of trees, especially where they were exposed to the wind.

FEBRUARY. Since now I have spoken so much of the cold, I hope it will not be too coldly taken, if in a few words I make it some way to appear unto our readers.

WE made three differences of the cold, all according to the places: in our house, in the woods, and in the open air, upon the ice, in our going to the ship.

FOR the last, it would be sometimes so extreme, that it was indurable; no clothes were proof against it, no motion could resist it. It would, moreover, so freeze the hair on our eye-lids, that we could not see; and I verily believe, that it would have stifled a man in a very few hours: we did daily find by experience, that the cold in the woods would freeze our faces, or any part of our flesh that was bare; but it was yet not so mortifying as the other. Our house on the outside was covered two third parts with snow, and on the inside frozen and hung with icicles. The clothes on our beds would be covered with hoar frost, which in this little habitacle was not far from the fire. But let us come a little nearer to it. The cook's tubs, wherein he did water his meat, standing about a yard from the fire, and which he did all day ply with melted snow-water; yet in the night-season, whilst he slept but one watch, would they be firm frozen to the very bottom: and therefore was he fain to water his meat in a brass kettle close adjoining to the fire; and I have many times both seen and felt, by putting my hand into it, that side, which was next the fire, was very warm, and the other side an inch frozen. I leave the rest to our cook, who will almost speak miracles of the cold. The surgeon, who had hung his bottles of syrups, and other liquid things, as conveniently as he could, to preserve them, had them all frozen. Our vinegar, oil and sack, which he had in small casks in the house, were all firm frozen. It may further in general be conceived, that in the beginning of *June*, the sea was not broken, and the ground was yet frozen; and thus much we found by experience in the burying of our men; in setting up the king's standard towards the latter end of *June*; and by our well, at our coming away in the beginning of *July*, at which time, upon the land, for some other reasons, it was very hot weather. Capt. James.

Monfieur L. J. confirmed to me what he had formerly told me, that upon the highest mountain of the Pyreneans, called *Pic de Midi*, he ascended at the end of *August*, or the beginning of *September* (in the morning) to the very top, where, he and his company spread a tent, and staid till the evening: he says, he found the air temperate where the sun did not beat; but on that side of their bodies, whereon the sun shone, the heat was exceeding great, and was offensive, even to them, that sat in the tent of oiled cloth, if they sat too near the sunny side of the tent: they sometimes had wind at the top of the hill, which they found to blow cool enough, (and found it very cold, when they returned to the bottom.) This hill is so high, that it may be seen from *Montauban*, which is 27 leagues distant.

WHEN I asked, whether the air in those places, where the sun did not beat, was considerably cold? he told me, that the exercise they had been put to in ascending the top of the hill (for the most part of the way they rid up) kept them from being very competent judges of that; but they found the wind northerly, though weak, yet very cooling; and the north side of the mountain was even then covered with snow, and scarce at all passable.

AN ingenious physician Dr. B. that has been in divers of the inland parts of *Africa*, among other answers, that he returned to the questions that I asked him, about the temperament of the air in those parts, gave me this memorable one, that having had occasion at *Morocco* to use some good dried fine jalap, that he had brought with him out of *England*, he found it by the heat of the air to be melted, and by consequence to be impulverable, in which state it continued whilst he lived in that country; but

when he was returned to *Tangier*, he found it both there, and in the neighbouring parts, pulverable again.

P. Fran-
cesco Bar-
retto rela-
zione della
provincia
di Mala-
var. p. 52.

Nel capo di Comorino si termina così l'estate, come l'inverno dalla parte, di là dal capo verso Notte, & dall'altra parte corrisponde il tempo assai contrario è diverso, di maniera che, chi va navigando, per quella costa nel mese di Ottobre, fino ad Aprile, naviga nell'estate, e non può in tutto questo tempo passare il capo per esser ivi la stagione dell'inverno, et il Padre, che reside nelle Chies che appartengono al Capo di Comorino ne alcune la state, il che è cosa di gran meraviglia, essendo cioè nel medesimo tempo nella distanza solamente di due, o tre miglia.

AN eminent virtuoso answered me, that in *Tirol* he had visited a very deep mine, into which he descended three hundred Klafters, which by his computation makes about eighteen hundred of our feet: that he passed not through, that he took notice of, one hot region by the way. That at the bottom of the mine he breathed very freely, because of the air shafts, by which access was given laterally to the superior air; and that being thinly clothed with one of the digger's habits, he found at the bottom the air temperate, as to heat and cold, though it were then summer-season of the year: so that notwithstanding what is said of antiperistasis, no intense cold was retreated thither, to shun the heat of the superior air.

AN ingenious gentleman, very conversant in our English mines, of one of which he is owner, answered me, that the deepest mine he had particularly visited, was a tin mine, whose depth was sixty-six fathoms, that is almost four hundred foot. That descending into this mine in summer, he found it very cold at the bottom, and the greatest part of the way going down, without perceiving any hot region. And when I asked him, how soon he began to find a sensible cold in descending, he told me, that he found it within two fathom or less of the orifice of the pit; and that in this and divers other mines he perceived a sensible cold to begin before he got down a yard, or perhaps half a yard beneath the upper part of the fast, as the mine-men call the solid earth, in which they distinguish from the loose earth, that lyes above it; and is, if I may so call it, the scurf of the earth, that is far more light and porous than the other, though it be upon this loose earth that plants grow, and into which even great timber trees themselves shoot, and spread their roots, seldom or never reaching to, or penetrating into the fast, though this lye sometimes near enough to the external surface of the crusty earth.

An exact Relation of the Pico Teneriff, taken from Mr. Clappham.

ABOUT the 20th of *August*, 1646, Mr. *Clappham*, together with Mr. *Philip Ward*, *John Webber*, *John Cowling*, *Thomas Bridge*, and *George Cove*, all of them very considerable merchants, and worthy of credit, with one guide, servants and horses to carry their wine and provisions, did set out from *Oratava*, a port-town in the island of *Teneriff*, situated on the north, at two miles distance from the main sea: they travelled from twelve at night till eight in the morning, by which time they got to the top of the first mountains towards the *Pico de Teraira*; here, under a very great and conspicuous pine-tree they brake their fast, dined, and refreshed themselves till two in the afternoon, and then proceeded through much sandy way, over many lofty mountains, but naked and bare, and not covered with pine-trees, as their first night's passage was, which exposed them to excessive heat, till they arrived to the foot of the *Pico*, where they found many huge stones, which seemed to have been fallen down from some superior part. But before we proceed farther to

give any account of this journey, give me leave here to interfert the opinion of Dr. *Pugh*, a person of very great reputation, at this time in the city, who lived twenty years himself on the place, both in the quality of a physician, and a merchant, and was very curious and inquisitive into all that was in the island: his opinion is, that the whole island of *Teneriff*, being a ground mightily impregnated with brimstone, did in former times take fire, and blow up all, or near upon all at the same time; and the many mountains of huge stones calcined and burnt, which appear every where about the island, especially in the south-west parts of it, were raised and heaved up out of the bowels of the earth, at the time of the general conflagration; and the greatest quantity of this sulphur lying about the centre of the island, raised up the *Pico* to the height, at which it is now seen. And he says, that any one upon the place, that shall carefully note the situation and manner of these calcined rocks, how they lye for three or four miles almost round the bottom of the *Pico*, and in such order one above another, almost to the very sugar-loaf (as it is called) as if the whole ground, rising up together with the accension of the brimstone, the torrents and rivers of it did with a sudden eruption, roll and tumble them down from the rest of the rocks, especially (as we said before) to the south-west; for on that side, from the very top of the *Pico*, almost to the sea-shore, lye huge heaps of these burnt rocks, one under another; and there remain to this time the very tracts of the rivers of brimstone, as they ran over all this quarter of the island, which has so wasted the ground beyond recovering, that nothing can be made to grow there, but broom. But on the north side of the *Pico*, few or none of these stones appear; and he concluded hence, that the vulcano discharged itself chiefly to south-west. He adds farther, that mines of several metals were broken and blown up at the same time; these calcined rocks resembling some of them iron ore, some silver, and others like copper, particularly at a certain place in these south-west parts, called the *Azuleios*, being very high mountains, where never any English but himself (that he ever heard of) was. There are vast quantities of a loose blueish earth, intermixed with blue stones, which have on them a yellow rust, as that of copper and vitriol, and likewise many little springs of vitriolate waters; here he suppoles was a copper-mine. And he was told by a bell-founder of *Oratava*, that out of two horse-loads of earth, he got as much gold as made two large rings: and a *Portuguese* told him, who had been in the *West-Indies*, that his opinion was, there were as good mines of gold and silver there, as the best in the *Indies*. There are likewise hereabouts nitrous waters, and stones covered with a deep saffron-coloured rust, and tasting of iron. And farther he mentions one Mr. *Gilbert Lambell*, a friend of his, who of two lumps of earth or ore, brought from the top of this side the mountain, made two silver spoons. All this he confirms from the late instance of the *Palm* island, eighteen leagues from *Teneriff*, where a vulcano was fired about twelve years since, the violence whereof made an earthquake in this island so great, that he and others ran out of their houses, fearing they would have fallen upon their heads: they heard the noise of the torrents of flaming brimstone, like thunder, and saw the fire as plain by night, for about six weeks together, as a candle in the room; and so much of the sand and ashes brought from thence, by the wind, by clouds, fell on his hat, as filled a sand-box for his ink-horn. Thus far he.

To resume therefore the narrative of their journey; about six a clock this evening, they began to ascend on the *Pico*; but being now a mile advanced, and the way no more passable for their horses, they quitted and left them with their servants. In this mile's ascent some of their company grew very faint and sick; and from Dr. *Pugh*'s report of eighteen in his company, that went up about the middle of *August*, long after this, but ten got up, and these had all drank very plentifully below; the rest
so

so disordered by fluxes, vomitings, and aguish distempers, they could go no farther: their horses hair stood upright, like bristles, with the vehement cold, who stood shaking, and refused to eat any thing till they came down. But calling for some of their wine, which was carried in small barrels on a horse, they found it so wonderfully cold, that they could not drink it, till they had kindled a fire to warm it, although yet the temper of the air was very calm and moderate; but when the sun was set, it began to blow with violence, and grew so cold, that taking up their lodging under certain great stones in the rocks, they were constrained to keep great fires before the mouth of them all night. About four in the morning they began to mount again, and being come about a mile up, Mr. *Cowling*, one of the company, failed, and was able to proceed no farther. Here begin the black rocks. The rest pursued their journey till they arrived to *Sugar-Loaf*, where they begin to travel again in a white sand, being foreshod with shoes, whose single soles are made a finger broader than the upper leather, to encounter this difficult and unstable passage, till they are half way up; and a spaniel, that went up afterwards with Dr. *Pugh*, (as he relates) went crying all the way, having his skin burnt off his feet; and then being ascended as far as the black rocks, which are all flat, and lye like a pavement, they climbed within a mile of the very top of the *Pico*: but Mr. *Clappham*, who was the foremost, would have persuaded Mr. *Cove* to descend again, as imagining the top of all on fire; but at last overcoming that apprehension, and persisting, they gained the summit, where they found no such smoke as appeared a little below, but a continual breathing of a hot and sulphureous vapour, which made their faces extremely sore.

In this passage they found no considerable alteration of air, and very little wind; but being at the top, it was so impetuous, that they had much ado to stand against it, whilst they drank the king's health, and fired each of them a piece: here they also broke fast, but found their strong waters had quite lost its force, and was become almost insipid, whilst their wine was rather more spirituous and brisk than it was before.

THE top on which they stood being not above a yard broad, is the brink of a pit called the *Caldera*, which they judged to be about a musket shot over, and near four-score yards deep, in shape like a cone, within hollow like a caldron, and all over covered with small loose stones, mixed with sulphur and sand, from heat; and stirred up with any thing, puffs and makes a noise, and so offensive, that Dr. *Pugh* was almost stifled with the sudden emanation of vapours, upon the removing of one stone of these; these stones are so hot, as they are not to be easily handled: they descended not above four or five yards into the *Caldera*, in regard of its sliding from their feet, and the difficulty; but some have adventured to the bottom. Other observable materials they discovered none, besides a clearer sort of sulphur, which looks like salt upon the stones.

FROM this famous *Pico* they could ken the grand *Canaries*, fourteen leagues distant; *Palma* 18, and *Gomera* 7 leagues; which interval of sea seemed to them no larger than the river of *Thames* about *London*: they discerned also the *Hierro*, being distant above twenty leagues, and so to the utmost limits of the sea much farther.

So soon as the sun appeared, the shadow of the *Pico* seemed to cover not only the whole island, and the grand *Canaries*, but the sea to the very horizon, where the top of the *Sugar-Loaf*, or *Pico*, visibly appeared to turn up, and cast its shadow into the air itself, at which they were much surpris'd. But the sun was not far ascended when the clouds began to rise so fast, as intercepted their prospect, both of the sea, and the whole island, excepting only the tops of the subjacent mountains, which seemed to pierce them through.

WHETHER

WHETHER these clouds do ever surmount the *Pico*, they could not say; but to such as are far beneath, they sometimes seem to hang above it, or rather wrap themselves about it, as constantly when the north-west winds blow: this they call the Cap, and is a certain prognostic of ensuing storms.

MR. *John Webber*, one of his company, who had made a journey two years after, arriving at the top of the *Pico* before day, and creeping under a great stone to shroud himself from the cold air, after a little space, found himself all wet, and admiring whence it should proceed, perceived it at last to come from a perpetual trickling of the water from the imminent rocks above him.

MANY excellent and very exuberant springs they found issuing from the tops of most of the other mountains, gushing out in great spouts, almost as far as the huge pine-tree which was mentioned.

HAVING stayed some time upon this top, they all descended by the sandy way, till they came to the foot of the Sugar-loaf, which being steep, even almost to a perpendicular, they soon passed: and here they meet a cave of about ten yards deep, and fifteen broad, being in shape like an oven or cupola, having a hole at the top, which is near eight yards over; by this they descended (an active Spaniard shewing them the way) by a rope, which their servants held at the top, whilst the other end being fastened about his middle, he swings himself, till being over a bank of snow, he slides down and lights upon it. They are forced to swing thus in the descent, because in the middle of the bottom of this cave, opposite to the overture at the top, is a round pit of water, resembling a well, the surface whereof is about a yard lower than the snow, but as wide as the mouth at the top, and is about six fathom deep, as Mr. *Lambell* reports, who plumbed it. They suppose this water not a spring, but dissolved snow, or water blown in; for some years it lyes so full, one cannot get into the cave for water trickling through the rocks.

ABOUT the sides of the grott, for some height is ice, and icicles hanging down to the snow: but being quickly weary of this excessive cold place, and drawn up again, they continued their descent from the mountains, by the same passages they went up the day before, and so about five in the evening arrived to *Oratava*, from whence they set forth: their faces were so red and sore, that to reduce them and cool them, they were forced to wash and bathe them in whites of eggs, &c.

THE whole altitude of the *Pico* in perpendicular is vulgarly esteemed to be two miles and a half.

No trees, herbs, or shrubs, in all the passage, but pines; and amongst the white sands a kind of broom, being a bushy plant; and at the side where they lay all night, a kind of cardon, which has stems of eight foot high, the trunk near half a foot thick, every stem growing in four squares, and emerging from the ground like tufts of rushes; upon the edges of these stems grow very small red buttons or berries, which being squeezed, produce a poisonous milk, which lighting upon any part of a horse, or other beast, fetches off the hair from the skin immediately: of the dead part of this they made their fires all night. This plant is also universal over the island, and is haply, and as I conjecture, a kind of euphorbium.

In some part of this island also there grows a crooked shrub, which they call *Legnan-vell*, which they bring for *England* as a sweet wood. There are likewise apricots and peaches, in standards, which bear twice a year: pear-trees also which are as pregnant; almonds of a tender shell, palms, plantanes, oranges and lemons, especially the pregnadas, which have small ones in their bellies, from whence they are so denominated. Also they have sugar-canes, and a little cotton and colloquintida; the roses blow at Christmas; there are good carnations, and very large, but tulips will

not

not grow or thrive there: samplier clothes the rock in abundance, and a kind of clover the ground. Another grafs growing near the sea, which is of a broader leaf, so luscious, as it will kill a horse, that eats of it, but no other cattle. There is also an herb which they make thread of. Eighty ears of wheat have been found to spring from one root, but it grows not very high; the corn of this is transparent and bright, like unto the purest yellow amber; and one bushel has produced 130 in a seasonable year.

THE canary-birds (which they bring to us in *England*) breed in the barrancos of gills, which the water has fretted away in the mountains, being places very cold. There are also quails, partridges larger than ours, and exceeding beautiful; great wood-pigeons, turtles at spring, crows, and sometimes from the coasts of *Barbary* appears the falcon. Bees are carried into the mountains, where they prosper wonderfully.

THEY have wild goats on the mountains, which climb to the very top of the *Pico* sometimes. Also hogs, and multitudes of conies: camels are brought from *Lance-rote*, besides other cattle.

FISH. The cherna, a very large and excellent fish, better tasted than any we have in *England*. The mero, dolphin, shark, lobsters without the great claws, muscles, periwinkles, and the clacas, which is absolutely the very best shell-fish in the world; they grow on the rocks, five or six under one great shell, through the top whereof they peep with their nebs, from whence (the shells being broken a little more open with a stone) they draw them forth. There is likewise another fish like an eel, which has six or seven tails of a span in length, united to one head and body, which is also as short. Besides these they have turtles and cabridos, which are preferable before our trouts.

THE island is full of springs of pure water, tasting like milk; and in *La Laguna*, (where the water is not altogether so limpid and clear) they percolate it through a kind of spongy stone cut in form of a basin.

THE vines which afford those excellent wines, grow all about the island, within a mile of the sea; such as are planted farther up, are nothing esteemed, neither will they thrive in any other islands.

FOR the Guanchios, or the ancient inhabitants, Dr. *Pugh* gives this full account.

SEPTEMBER 3. about twelve years since, he took his journey from *Guimar*, a town inhabited for the most part by such, as derive themselves from the old Guanchios, in the company of some of them, to view their caves, and the bodies buried in them. This was a favour they seldom permit to any, (having in great veneration the bodies of their ancestors, and likewise being most extremely against any molestation of the dead) but he had done many several eleemosynary cures amongst them, (for they are generally very poor, yet the poorest thinks himself too good to marry with the best Spaniard) which endeared him to them exceedingly, otherwise it is death for any stranger to visit those caves or bodies.

THESE bodies are sewed up in goat-skins, with thongs of the same, with very great curiosity, particularly in the incomparable exactness and evenness of the seams; and the skins are made very close and fit to the bodies: most of these bodies are entire, the eyes closed, hair on the head, ears, nose, teeth, lips, beard, all perfect, only discoloured, and a little shriveled; likewise the pudenda of both sexes. He saw about three or four hundred in several caves; some of them are standing, others lye on beds of wood, so hardened by an art they had, (which the Spaniards call *curar*, to cure a piece of wood) which no iron can pierce or hurt. He said, that one day being a hunting, a ferret (which is in use there) having a bell about his neck, ran after a coney into a hole, where they lost the sound of the bell; the owner being afraid he should

should lose his ferret, seeking about the rock and shrubs, found the mouth of a cave, entering in, was so affrighted, that he cried out : it was at the sight of one of these bodies, very tall and large, lying with his head upon a great stone, his feet supported by a little wall of stone, the body resting on a bed of wood, as before was mentioned.

THE fellow being now a little out of his fright, entered in, and cut off a great piece of the skin, that lay on the breast of his body, which the doctor says was more flexible and pliable than ever he felt any kid leather glove, and yet so far from being rotten, that the man made use of it for his sail many years after.

THESE bodies are very light, as if made up of straw : and in some broken limbs, he observed the nerves and tendons, and also some strings of the veins and arteries very distinctly.

HIS great care was to enquire of these people, what they had amongst them of tradition, concerning the embalming and preservation of these bodies ? From some of the oldest of them (above a hundred and ten years of age) he received this account : that they had of old one particular tribe of men, that had this art amongst themselves only, and kept it as a thing sacred, and not to be communicated to the vulgar ; these mixed not with the rest of the inhabitants, nor married out of their own tribe, and were also their priests and ministers of religion : that upon the conquest of the Spaniard, they were most of them destroyed, and the art lost with them, only they held some traditions yet of a few ingredients, that were made use of in this business.

THEY took butter of goat's milk, (some said hog's grease was mingled with it) which they kept in the skins for this purpose ; in this they boiled certain herbs ; 1st, A sort of wild lavender, which grows there in great quantities on the rocks. 2dly, An herb called jara, of a very gummy and glutinous consistence, which now grows under the tops of the mountains only. 3dly, A kind of a cyclamen, or sow-bread. 4thly, Wild sage growing plentifully in this island. These, with stones bruised and boiled in the butter, rendered it a perfect balsam. This prepared, they first unbowelled the corps ; and in the poorer sort, to save charges, they took out the brain behind : and these poor also were sewed up in skins with the hair on, whereas the richer were (as was said before) put up in skins so finely and exactly dressed, as they remain most rarely pliant and gentle to this day. After the body was thus ordered, they had in a readiness a lixivium, made of the bark of pine-trees, with which they washed the body, drying in the sun in summer, and in stoves in winter, this repeating very often. Afterwards they began their unction with the balsam, both without and within, drying it again, as before : this they continue till the balsam had penetrated itself into the whole habit, and the muscles in all parts appeared through the contracted skin, and the body became exceeding light ; then they sewed them up in the goat-skins, as already mentioned. He was told by these ancient people, that they have above twenty caves of their kings and great persons, with their whole families, yet unknown to any but themselves, and which they will never discover. Lastly, he says, that bodies are found in the caves of the grand *Canaries*, in sacks, and quite consumed, not as those in *Teneriff*. Thus far of the bodies and embalming. Anciently when they had no knowledge of iron, they made their lances of wood, hardened as before, some of which the doctor has seen : he has also seen earthen pots so hard, that they cannot be broken, of these some are found in the caves, and old barrancos, and used by the poorer sort of people, that find them, to boil meat in ; likewise they did curar stone itself, that is to say, a kind of slate now called tabona, which they first formed to an edge or point, as they had occasion to use them, either as knives, or lancets to let blood.

THEIR food was barley roasted, and then ground with little mills, which they made of stones, and mixed with milk and honey; this they still fed on, and carried it on their backs in goat-skins.

To this day they drink no wine, nor care for flesh; they are generally very lean, tall, active, and full of courage.

HE himself has seen them leap from rock to rock, from a very prodigious height, till they came to the bottom, sometimes making ten fathom deep at one leap. The manner is thus:

FIRST, they tertiate their lance, (which is about the bigness of a half-pike) that is, they poise it in their hand; then they aim the point of it at any piece of a rock, upon which they intend to light, sometimes not half a foot broad; at their going off they clap their feet close to the lance, and so carry their bodies in the air; the point of the lance first comes to the place, which breaks the force of their fall; then they slide gently down by the staff, and pitch their feet upon the very place they first designed, and from rock to rock, till they come to the bottom.

THEIR novices sometimes break their necks in learning. He added several stories to this effect, of their great activity in leaping down rocks and cliffs, and how eight and twenty of them made an escape from the battlement of an extraordinary high castle in the island, when the governor thought he had made sure of them.

HE told also, (and the same was seriously confirmed by a Spaniard, and another Canary-merchant then in the company) that they whistle so loud, as to be heard five miles off; and that to be in the same room with them when they whistle, were enough to endanger breaking the tympanum of the ear: and added, that he being in the company of one, that whistled his loudest, could not hear perfectly for fifteen days after, the noise was so great.

HE affirms also, that they throw stones with a force as great as that of a bullet, and now use stones in all their fights, as they did anciently.

MR. Sydenham told me this day, that upon the 18th of *August*, he and his company began their journey toward the pike of *Teneriff*, setting out from *L'Oratava*, a town seated on the lower part of the mountain, from which town to the sea there are three miles of way always descending.

HE began his journey on Sunday about 10 a clock at night, and travelled till five in the afternoon of the Monday following, resting two hours by the way; the ground was continually rising, and during this time they travelled about 10 miles of their way upon mules.

RESTING upon Monday till 12 a clock at night, they resumed their journey, and travelled till about 9 in the morning, at which time they arrived at the top of the sugar-loaf, or highest pile of the mountain.

THEY went up on the south side of the hill, on which side there was no snow, though on the north side there were much. They stayed about two hours on the top of the sugar-loaf, and then returned to that part of the hill, where they had lodged the night before.

I ASKED Mr. Sydenham, what was the estimate made by the most knowing persons of the island, of the height of the hill? and he told me, that the guides accounted it to be one and twenty miles high from the town, which, as was noted before, is seated three miles above the sea. And he added, that a seaman with great confidence affirming himself to have accurately enough measured by observations made in a ship, and to have found the perpendicular height of the hill to be about seven miles.

I ASKED him also from what distance the top of the sugar-loaf could be seen at sea, according to the common opinion of seamen? he answered, that the distance was wont

to

to be reckoned threescore sea leagues, of three miles to a league, adding, that he himself had seen it above forty leagues off, and yet it appeared exceeding high, and like a bluish pyramid, manifestly a great deal higher than the clouds. And he also told me, that sometimes men could from thence see the island of *Madeira*, though distant from it 70 leagues; and that the great *Canary*, though 18 leagues off, seemed to be very near them, as if they might leap down upon it.

HE told me, that the higher part of the region of snow was two miles, or two miles and a half lower than the foot of the sugar-loaf; and that on the upper part of the hill they felt no wind.

MR. *Sydenham* told me, that being at the top of the sugar-loaf, drinking the king's health, he endeavoured to shoot off a birding-piece he had carried up with him, but though he snapped it above twenty times, he could not make it go off; whereas when he came down into the ordinary air, the first time he tried to shoot, it went readily off. I asked him, whether he had taken notice, that the flint struck out any sparks of fire or no at the top of the hill, and whether he had mended and altered the flint coming downwards? To the first he answered he did not remember; to the other, that he remembered he did not.

HE also told me, that having carried up a *borracha* of sack, when they came to the top of the mountain, they drank divers healths very freely, but could not find themselves heated, or sensibly discomposed by the wine; whereas when they were come down into a thicker air, they manifestly felt the heady operation of the liquor, which then made their guide and one of their company drunk.

HE described the sugar-loaf to be in the midst of a barren plain, in the upper part of the mountain, and to be exceeding steep. The top of the sugar-loaf is made shelving inward almost like a dish. But in many places of it there appear little holes (regularly placed) as it were so many little vents to a great fire burning in or below the bowels of the mountain. He told me, that the guide dissuaded him from going to the middle of this shelving top, affirming it to be exceeding dangerous: but he ventured to thrust the scouring stick of his gun somewhat deep and rudely into one of those holes, from whence there arose a hot steam, which had like to have killed him, and hindred him from further trials. He added, that the top of the mountain seemed to be little else than stones and sulphur, and that there were great store of pieces of brimstone, which are guessed to be sublimed up from the internal parts of the hill.

BEING asked, whether he was sick or no in the ascent? he said, that both he and all his company, which were about a dozen men, were sick for three or four hours, when they came into the subtle and piercing air of the upper part of the mountain; but as they went down again, they were not sick. And being asked, what kind of sickness it was they felt? he said, it was like sea-sickness.

HE told me, that the sack they carried up with them to refresh themselves, seemed to them at the top of the mountain so very cold, that they were not able to drink above two or three drops at a draught, by reason of the operation of the excessive cold upon their teeth. He added upon my enquiry, that his feet were not more than ordinarily warm, and yet one of the two pair of pumps he carried up with him were burnt off his feet by the brimstone.

WHEN I asked him about the difference of seasons at the same time in the same mountain, he told me, that he passed over one of them by name.

ON the one side of which it was excessively hot near the top or ridge, as well, though not quite so much, as in the lower regions on the side of the mountain; but within a mile or two on the other side of the ridge he found winter-weather as to cold and storminess, and yet there was snow as well on the other side as on this.

To what depth the water will be frozen in hard winters.

To what depth the earth will be frozen in that season.

WHETHER Muscovian ice be considerably, or at least sensibly harder than English ice.

WHETHER by casting up water, or by spitting, the liquor will freeze before it comes to touch the ground.

WHETHER brandy, sack, &c. will freeze in *Russia*.

WHETHER instruments of iron and steel be much more brittle there than here.

OF the cracking of the timber in wooden houses, and the causes of it.

OF the preservation of flesh, fish, herbs, eggs, &c. in hard weather.

OF the curing of those whose nose, cheeks, &c. are frozen.

OF the symptoms of those, that are frozen to death.

OF the keeping of dead bodies.

T I T L E XX.

Of the Air in reference to Light, its Perspicuity, Opacity, Reflections, Refractions, Colours, Light, and Lightning.

A VERY learned traveller affirmed to me, that having occasion to reside sometimes on the *Riviera* or coast of *Genoa*, he had often observed, that from a high place he could both morning and evening clearly discern the island of *Corfica*, and sometimes also other places in that sea, though he could not see them at noon, how fair and clear so ever the weather was, when the sun was in or near the meridian.

His late majesty king *Charles* the second, doing me one day the honour to discourse about several marine observations, was pleased among other things to acquaint me with this rare phænomenon. He was one day walking upon the beach on the strand, not far from *Dover*, to enjoy the fresh air, and the prospect of the sea, when casually looking forwards to the verge of the visible horizon, he was very much surpris'd to discover there a new coast, with rising and falling grounds, newly, as it were, emerged out of the ocean, in a place, where no such thing had been seen before. The strangeness of this unlooked-for apparition made him suspect something of illusion offered to his eyes by the beams of the sun, that shone upon the neighbouring objects; wherefore he rubbed his eyes, and the new scene not vanishing, he called to his royal highness the duke of *York*, (who was present when his majesty was pleased to make me the relation) and to some of the attending courtiers, that were nearest at hand, to make them partakers and witnesses of this delightful spectacle, which, after it had been gazed on a little while, did somewhat slowly disappear, as if it had sunk down again into the ocean. Of the cause of this rare phænomenon, I ventured to propose to the king this conjecture: that the place, where it was seen, lying the same way that the coast of *France* did, and that coast being but a little too far off to be discerned before, it might very well happen that either by action of the sun, or rather by subterranean steams, the air interposed between the shore and his majesty's eyes was filled with vapours and exhalations, that made it much more refractive than formerly; and by help of this supervening refraction, the French coast, that lay beyond it, was raised and as it were lifted up, in reference to the sight, and so became visible as long as that new refraction lasted: and when the steams, that occasioned it, were either got up too high, or were by the winds or sun too much dissipated or dispersed, the apparition ceased, together with the unusual refraction that caused it. And in favour of this conjecture

jecture I alledged that familiar experiment, in which a piece of gold, or the like convenient object, being put into the bottom of an empty cup, and the eye being so placed, that the object is but just hid from it by the interposition of the side of the cup, if water be poured into the vessel, though neither the eye nor the object be at all removed, yet the piece of gold will be plainly seen, because the surface of the water, which is a thicker medium than the air, breaking the rays, that tend from the object towards the beholder's eye, according to the laws of refraction, that is from the perpendicular they are so bended, that those fall now into the pupil, that, if it were not for the water, would either fall upon the side of the cup, and so be hindered from passing forward; or else would fall upon the eye-lids or eye-brows, or some other part above the pupil, and so would not make the object visible.

THE duke of *York* was also pleased to tell me, that he was somewhat surprized, when being near the borders of *Scotland*, in a season, that did not promise much fair weather, he saw one morning the sky very red, and thereupon said, that he feared they should have foul weather, according to the usual prognostic of countrymen and mariners: but some of the Scottish nobility, that attended his highness, told him, that in that country such red mornings did not bode a foul day, but rather promise a fair one, which prediction of theirs was justified by the event. Upon which occasion I enquired of a very intelligent Scottish nobleman; how far the observation held in his country? to which he answered, that with a due limitation it was most commonly true; for though when the redness seems to be very near the ground, and appears in somewhat narrow streaks of an intensified red, it signifies bad weather; yet if the morning redness appears elevated in the air or sky, especially if the wind be easterly, it usually foretels a fair day.

Some Observations of Capt. James, in his Northern Voyage, Mr. J. T. and others.

FEBRUARY. I practised some observations by the rising and setting of the sun, calculating the time of his rising and setting, by very true running glasses. As for our clock and watch, notwithstanding we still kept them by the fire-side in a chest, wrapped in clothes, yet were they so frozen, that they could not go. My observations by these glasses I compared with the stars coming to the meridian: by this means we found the sun to rise twenty minutes before it should; and in the evening to remain above the horizon twenty minutes (or thereabouts) longer than it should do: and all this by reason of the refraction. Captain *James*.

MARCH. This evening the moon rose in a very long oval alongst the horizon.

APRIL. The weather continued with this extremity until the fifteenth, at which time our spring was harder frozen than it had been all the year before. I had often observed the difference betwixt clear weather and misty refractious weather, in this manner: from a little hill, which was near adjoining to our house, in the clearest weather, when the sun shone with all the purity of air that I could conceive, we could not see a little island, which bare off us south south-east some four leagues: but if the weather were misty (as aforesaid) then we should often see it from the lowest place. This little island I had seen the last year, when I was on *Danby* island. The 13th I took the height of it instrumentally, standing near the sea-side, which I found to be 34 minutes, the sun being 28 degrees high. This shows how great a refraction here is. Yet may this be noted by the way, that I have seen the land elevated, by reason of the refractious air, and nevertheless the sun hath risen perfect round.

JANUARY 6. I observed the latitude with what exactness I could, (it being very clear sun-shine weather) which I found to be 51, 52. This difference is by reason, that here is a great refraction.

JANUARY

JANUARY 21. I observed the sun to rise like an oval alongst the horizon; I called three or four to see it, the better to confirm my judgment, and we all are agreed, that it was twice as long as it was broad. We plainly perceived withall, that by degrees as it got up higher, it also recovered roundness.

ATTENDING upon Sir *Peter Wyck*, in his journey for *Warsaw* the beginning of June 1677, whilst we lay about three Polish miles from the city, attending the preparations for his reception there, we had very clear and extreme cold weather; and for two days together we observed the sun and two parhelions, or three suns, from above ten a clock to near twelve, not the least cloud appearing in the air, but that so serene, that we took notice of the icy spangles in the air, flying about like atoms in the sun's beams. This is also worth taking notice of; that whereas in ordinary frosty weather any smooth iron, or other metal, whether heads of sticks, pomels of swords, or barrels of guns, being brought out of the open air into a warm room, there will presently, first a dulness in the glass, and then drops of water appear: at this time there would immediately appear the likeness of an hoar frost. Now, whether the particles of cold be so subtil as to pierce or enter into polished metal, I will not determine; though the experience of wetting one finger with his spittle, and forthwith laying it to iron, when it freezes hard, by its immediate adhesion, even in the moment of touching it, would make some way for the affirmative. That same month returning back from *Warsaw*, I saw, upon my journey, the sun rise with a large pillar, coloured like a rain-bow, perpendicular over it, out of a clear horizon; and I remember monsieur *Hevelius* told me, he observed it once set with the like, N.

IN *Cornwall* they observe in their driving home levels or sink, the waters do also manifestly partake of the minerals; for in some mines they are sanative, where iron is observed, and in others apt to cause wounds to fester and rankle. As the first was most manifest at *Karne-Key*, the latter at *Relistian*, both famous tin-works.

ASKING of a chemist, that travelled with a famous virtuoso of my acquaintance over part of the *Alpes*, that is said to be much subject to thunders, divers questions about thunder, I had, among other answers, this, that he and my friend being together at the top of a forked mountain, between whose parts there lay a valley, that seemed almost covered with a thick cloud; and though the weather were clear at both the tops, he observed, that the subjacent cloud being big with thunder, the lightning appeared quite through it, and seemed to lye deep in it, so that casting his eyes down upon the cloud, he fancied, that what he saw, was (to use his own comparison) as if a shining fish were moving to and fro very swiftly in a somewhat troubled water. If I had seasonably had the relation, I had enquired of my friend about it; but I was the more inclined to believe it, because I remember, that passing over a part of the *Alpes*, less high than that where the recited observation was made, though it was very fair weather, and a clear sky at the top of the mountain where we were, yet a great way beneath us we saw dark clouds, through part of which we afterwards in our descent were obliged to pass, though then (whether part of the matter had been in the mean while discussed, I examine not) it seemed to us little different from a thick fog, which when we had passed thorough, we found the weather fair and clear enough to the foot of the mountain.

MEETING with an inquisitive nobleman, that lived long at *Naples*, I asked him, whether he had ever seen any of those famous apparitions, that are said sometimes to shew themselves in or near the *Sicilian* streight, and is known by the name (if I mistake not) of *Morgane*? to this he answered me, that during the spring-time, he had once the curiosity to try, whether this tradition had so much ground as was commonly believed; and that accordingly on several fair mornings he rose before the sun, and
looked

looked solicitously along the coast, without seeing any thing that answered his expectation: but not being discouraged by these disappointments, he one morning perceived, as he thought, two steeples in a neighbouring town, where he knew there was but one; which phænomenon inviting him to continue his curiosity, he chose the first fair and cloudless morning to rise early on; and casting his eyes towards the lately mentioned town, and the coast it was not remote from, he was surpris'd with a delightful prospect of a new town beyond the other, and incomparably greater than it, and furnished, as it seem'd to him and a doctor of physick that accompanied him, with walls and towers, and steeples and houses, and other things, that were delightful, as well as wonderful to behold. But he answered me, that the colours were not near so lively as the figures, being for the most part somewhat dim, though adorned here and there with some redness: but this odd spectacle, as it was not invariable during the whole time it lasted, did not continue very long; for when the sun was gotten up to such a height above the horizon, as made his beams powerful, they quickly confounded all these airy structures in a kind of chaos, and made the fantastick city vanish.

Moist vapours are not the only cause or sign of the opacity of the air, since that dry blighting east wind, which from the effects country people call a red wind, makes the air at a distance seem bluish and thick. This is the wind, which these two years last past has been so pernicious to apples, and indeed to all sorts of trees, not only to blast the fruit, but the very leaves of such trees as it met withal, just in the tender (as the woodmen call it) *i. e.* when they are newly expanded out of the buds. Mr. *J. T.*

THAT air is sometimes more clear and transparent, and sometimes more dark, and, as it were, muddy, being clogged and opacated with terrestrial steams, is every man's observation. But there are some phænomena, that depend upon the density, diaphaneity, &c. of the air, that are not so vulgarly taken notice of: for besides those, that require skill in the doctrine of refractions, on which therefore I shall not now insist; there are some others, that may be worth your notice, which I shall give a taste of.

CONSIDERING the differing accounts, that are given by good authors, of the number of the fixed stars, and comparing them with some observations of our own, I was thereby, and upon some other grounds, induced to suspect, that the differing and unheeded constitutions of the air might occasion a difference in assigning the number of the stars; which made me enquire of several navigators and travellers, some into the torrid zone, and others into the frigid ones, what difference they found in contemplating the stars in those climates, and in ours; and by this enquiry, I learned, that in some places, where the air is very pure, celestial observations may be more happily made. And particularly because I supposed, that intense cold, by precipitating the darkning vapours out of the air, may probably make it more defecate and clear, I desired an ingenious physician, that travelled in *Muscovy*, to take notice of any thing, that should favour or disfavour this conjecture. In compliance with which request of mine he informed me, that travelling one night in a sled in the more mediterranean parts of *Russia*, the weather being extraordinary cold, he was invited to quit his sled a little to consider the sky, where he saw so many stars, and so much brighter than he had ever seen before, that he was almost as much surpris'd as delighted with so glorious a spectacle, which he shewed to some of his fellow-travellers, that shared in his wonder.

AND this brought into my mind, that remembring, that the ingenious captain *James* being forced to winter in *Charlton* island, which, though but of the latitude almost of *Cambridge*, is but little, if at all, less cold than *Nova Zembla* itself, I should probably find something pertinent to our present subject in so diligent an observer. I resorted to his voyage, where I met with these notable observations.

JANUARY 30 and 31, there appeared in the beginning of the night more stars in the firmament than ever I had seen before, by two thirds. I could see the cloud in cancer full of small stars; and amongst the Pleiades a great many small stars. About ten a clock the moon did rise, and then a quarter of them was not to be seen. The wind for the most part of this month hath been northerly, and very cold, &c. Captain James, p. 62.

The Russian emperor's physician confirmed to me, by word of mouth, what he had some years since told me in a letter, that one night, which was exceeding cold and clear, being awakened out of his sleep by a shake, that had like to have overturned his bed, he looked out and saw more stars by far than ever he saw in *England*, or the neighbouring parts of *Europe*, and particularly, that he saw many about the seven stars, or the Pleiades, and divers others he had not seen before in several other parts of the sky. He farther told me, that these stars seemed far more beautiful and bright than was usual, insomuch that he doubts not, that if it had not been for the snow, some of them would have cast a discernible shadow. For confirmation, he saith, that the phenomena were not only taken notice of by him, but by others, that travelled with him; and that though he often gazed at the sky, since that time he never could see there near so many stars, nor so bright.

DECEMBER 4. I had not time the last week to tell you of something, that to us, that have not been long in this country, seems strange, but the people of this place say happens very often.

ON the 29th of the last month, after I had written and sent away my letters, looking out of the duchesses's window, to see what weather it was, I saw towards the N. E. alongst the horizon, it looked as light, and just as if it had been break of day, (it was then about a quarter past eleven) and gave as great a light: I went then into the drawing-room, and looking out of that window, could look more northerly, and saw it was more light due N. and saw several streaks of light, like the tail of a blazing star, all pointing N. and S. one of which was as long or longer than that we saw last year, for it reached from the horizon, and passed between *Charles's* wain and the N. star, and reached up just over our heads. The small ones sometimes disappeared; and then we saw others of the same dimensions appear in other places; they were all near the great one: two of them seemed as if their light had come from the two guards in *Charles's* wain; and when they vanished, others appeared more south. I went to the other side of the house, and saw that the light reached from the W. or W. N. W. by the N. to the E. or E. N. E. I did not go out, because it blew very hard, and was very wet, contenting myself to see it out of the house, but sent *Geo. Man* up the hill, who saw the same, and it was so clear they could see the Frith.

ABOUT the new moon before, there was such a light as this seen by lord *Belcarras*, as he came in the night from *St. Andrew's* to his house, and by the seamen of the yacht at *Leith*, and by some here in town: but though the sky was not then so clear, there being broken clouds, yet it gave such light, as they could read very plainly, as they told me: that began about 7, and lasted till 9. This last I did not see till after 11, and at a quarter of 12 it began to lessen, at which time I went to bed, and the tails were then no more to be seen. Tell Dr. *Flamsteed* of this, and know of him, whether he has seen or heard of such kind of things.

THIS was from his royal highness the duke of *York*, then high commissioner in *Scotland*.

AN intelligent gentleman, that lived in *Africk*, being asked by me, how far off he was able to see the top of the *Pico of Teneriff* at sea? replied, that by the estimate of the captain of the ship, it was near 50 leagues, and yet it appeared to him so high above some clouds, and so near, that he was fain to cast his head up to see it.

T I T L E

T I T L E XXI.

Of the Operation of the Air on the Consistency of Animal Substances.

AS on the one side the schools teach the air to be a simple and elementary body, that is, only hot and moist: so on the other side, the generality of men are so accustomed to judge of things by their senses, that not finding the air to be a visible body, they ascribe less to it than even the schoolmen do; and what is invisible, they think to be next degree to nothing. And indeed both the one sort of men and the other are wont to consider the air only as a receptacle, that barely harbours the visible and palpable bodies committed to it, or as it were deposited in it, without acting upon them, unless it be perhaps a little upon the account of its manifest qualities, heat and moisture. But for my part, who look upon the air under another notion, and think it may as well alter as receive the bodies, that lye exposed to it; I am apt to allow it, in reference to some bodies, certain other faculties and powers, among which some may be called generative and maturative, and others corruptive; and this not only in respect of animals and other bodies of a slighter texture, but even of salts and minerals themselves.

AN observing man, that had sailed to and fro between *Europe* and the *East-Indies*, answered me, among other things, about their way of transporting cheese: that the cheese they used to take along were *Cheeshire*, of a very considerable thickness, which they inclosed in leaden boxes fit for them, and thereby were able to preserve them found till they came to the *East-Indies*. But in case they were not able, or neglected to make use of such boxes, he several times observed, that cutting a cheese in two, when they were any thing near the equinoctial, that most part of it would be very dry and brittle, and seemed as if it were spoiled; whereas the parts about the middle were so fat and soft, as if all the unctuous parts, that were wanting in the dried portion of the cheese, had retired thither, and was between cream and cheese. Which conjecture was not contradicted by this, that if they cut some of these cheeses, when having left the torrid zone behind them, and had made a good progress in the temperate zone, they found their external portion good, and the consistence of the cheese uniform enough.

QUERE, whether the moist particles, that fly in the air, be not the great cause of all corruption of bodies, since *Acofta* says, that in *Peru*, where it seldom rains, all things, like dead bodies, keep a great while uncorrupted? The like may be observed of *Egypt*, if it be not to be rather imputed to the nitrous salt, with which the air of that country so much abounds. Mr. J. T.

A MAN of letters, that divers times crossed the line in great Portugal ships, answered me, that when they came near it and under it, he observed among other things, that there was a very manifest change made in the consistence of their biscuit; that most of their meat, and even their salt fish was much impaired, so that they were scarce able to eat it; and that their pilot, who had been 23 times in the *Indies*, assured them he observed, when they came to the equinoctial, that fresh water would not there be at all troubled or stinking, but clear and sweet, as if it were but newly put into the cask.

DOCTOR *Stubbes* being enquired of by me concerning, &c. told me, that in *Jamaica* the silken stuffs, that were brought thither, will rot even whilst they keep their colour, if they be shewn to the air; though if they be not shewed thereto, but kept up close, they were not observed to rot, or be discoloured.

T I T L E XXII.

Of the Operation of the Air on the Consistency of Vegetable Substances.

MAY 16. We opened a small glass receiver ground to a plate of glass, in which there had been included for three years and some months, (though I know not how many) the half of a lemon cut transversely, together with a mercurial gage: the lemon kept its colour pretty well, and its shape very well, save that at the orifice the upper part of the pulp was depressed, seeming as it were dried up by the recess of the liquor contained in it; which liquor did now stagnate upon the glass plate. When this began to be disjoined from the upper glass, there rushed in, not without noise, a pretty deal of external air, which argued, that the air afforded by the included lemon in so long a time, had not been near sufficient to fill the cavity of the receiver. Neither the half lemon nor the liquor had any ill scent, or other sign of putrefaction or corruption; neither of them had the least mould, which gave me a suspicion, as far as it could be grounded upon this experiment, that such a mould, as might have been expected, being (as may be guessed by the microscope) a congeries of a very small kind of vegetables, could not, any more than many greater ones, be produced without the concurrence of the air. The liquor was clear enough, and without fæces, being in colour between brown and reddish. It contained an acid taste; and when I put a little of it upon syrup of violets, it turned it to a purplish colour; and, which is more, being put upon small fragments (not powder) of red coral, presently began manifestly to corrode them, and that in the cold.

To the heat and piercing moisture of the air combined together may be referred the observation of an intelligent scholar, from whom, when I asked him, what he had taken notice of about these qualities, when he sailed under or near the line, (which he did several times) he told me, that divers pastils or lozenges, that he was wont to carry in his pockets, were so dissolved, that they spoiled his pockets, and obliged him to cut them out; though the pastils of the same kind did never lose their old consistence till he came near the equator, nor keep their new consistence after he had passed some degrees beyond it, but grew solid again as before.

T I T L E XXIII.

Of the Operation of the Air on the Consistency of Mineral Substances.

INQUIRING of an ingenious Swedish gentleman, that was a great dealer in the metals his country abounds with, whether the great cold of sharp winters in those northern climates had not a sensible operation upon iron; I learned from him, that in the chief copper mine (which he had curiously visited) being to draw up the ore from an exceeding great depth, they fastened their baskets, not as they use in other mines, to iron chains, but to ropes made of ox or bull-hides; and that chiefly for this reason, that during the hard winter-frosts, that are there usual, the links of their iron chains were very subject to be broken by the great cold joined to the weight of the ore, to the great danger, and oftentimes the destruction of the poor workmen, that were digging beneath: which inconvenience was avoided by employing leather, which the cold could not make brittle, instead of iron.

ASKING an ingenious master of a glass-house, whether he had not observed, that glasses, though as well nealed as is ordinary, would sometimes of themselves break with a noise long after; he answered me affirmatively; adding, that particularly hav-

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ing one time had an occasion to lay by, for about half a year or longer, a numerous parcel of glasses, when he came to take them out, he found, that about a fourth part of the whole batch was frozen of themselves; and that in most or all of them, the cracks proceeded from some seeming stone or great grain of sand, which yet indeed was not sand, but some part of salt, that had not obtained a sufficient comminution.

A LEARNED gentleman, that is owner of an iron mine, informs me, that he has a house in *Suffolk*, within 6 miles of the sea; and though the house be but 80 years old, yet the iron bars of the window, that look towards the sea, are swelled, and (as he calls it) rotten, being brittle, and easy to be crumbled into powder. And when I asked him, whether the wind, that came from the sea to these windows, were not southern, he answered affirmatively. And to confirm what I was saying of the operation of sea-salt upon iron, he told me, that having had occasion to cause many bars of iron to be laid in a place upon the neighbouring shore, above the high-water-mark, a great storm chanced to increase the tide so far as to drench those bars for some hours after; which remaining in the air, they were very much impaired, great thick flakes being easy to be struck off from them, when they came to be hammered.

A VERY experienced mason informed me, that the cathedral of *Salisbury* is made of *Purbeck* stone, which in the air grows softer, and will moulder away; and so will some *Blechington* stone, though not exposed to wet; whereas the stones dug up at *Painswick*, within four miles of *Gloucester*, being very soft and friable at first, will by lying in the air (as he has particularly observed) acquire a crust hard and glassy like marble; and the oftner it is washed, the sooner will it acquire this hard and yellowish crust, which reaches but a very little way (scarce the thickness of half a crown) beneath the surface contiguous to the air.

T I T L E XXIV.

Of the Air in Reference to Fire and Flame.

A GENTLEMAN of my acquaintance being asked by me about the burning of candles in grooves (or sutts) that are not furnished with air-shafts, he told me, that the depths I desired to be informed of were very uncertain, and varied considerably, according to the different nature of the soil, and perhaps other circumstances; so that sometimes a candle will go out much sooner, and sometimes it would continue burning, though it were let down to the depth of eight, ten, or more fathom. That when they come into close ground, though their candle will burn at first, yet after a while working, (more especially if the stone be full of mundick) the dust raised by their working will make their candles go out, so that they must leave working for a time, except they will be at the charge of conveying down air by pipes. I mention this as different from other sorts of damps. N.

Experiments touching the Relation between Flame, Air.

THE burning of candles, &c. under a glass bell.

THE burning of spirit of wine under a glass bell.

THE burning of match, touchwood, sponck, &c. under a bell.

THE keeping of animals under the same instrument whilst the flame is burning.

THE burning of bodies to ashes in sealed glasses.

THE doing the like in exactly closed receivers.

THE burning of cotton in a sealed glass.

THE burning of the mixture of flames under water in an E. R.

THE burning of spirit of wine and oil of turpentine in glass vessels with slender necks.

THE experiment of burning gunpowder.

ANOTHER of the pistols not firing in an E. R.

THE burning of a saline substance in an E. R.

THE burning of mixtures of salt-petre in an E. R.

T I T L E XXV.

Of the Air in Reference to Fermentation.

Novemb.

WE took a small handful of raisins, and having put them into a bolthead, (not large, but half filled with water) we drew out the air, and then we removed the portable and exactly closed receiver, and put it on the digestive furnace, that the warmth of that place might promote the fermentation in spite of the unfavourableness of the season of the year. After a while there appeared signs of fermentation by the emerging of the raisins, which swam for some days on the top of the water, most of them beset with numerous bubbles; nor did above very few of them subside at last, though after some days the bubbles grew fewer and fewer, and there appeared a sediment at the bottom of the glass.

A FORTNIGHT after they were first sealed up, the upper part of the glass was accidentally broken whilst I stood by, whereupon the external air rushed in with some noise; and I taking the vessel in my hand, perceived the surface of the liquor to be overspread with bubbles, almost like the froth of bottle-drink: there seemed to me to come out at the little orifice made, where the apex was broken off, a visible fume, which had a somewhat languid smell. The liquor was high coloured of the raisins, and seemed to have extracted something from them, that gave it a better consistence than that of water.

T I T L E XXVI.

Of the Air as the Receptacle of Odours.

T I T L E XXVII.

Of the Operation of the Air on the Odours of Animal Substances.

MAY 23. We opened an exhausted receiver, wherein was pretty store of verjuice, or green and sour grapes. And though they had lain there, we are sure, about three years, and possibly much longer, yet there appeared no mouldiness at all upon any of them: but the surfaces of the uppermost grains were somewhat discoloured, perhaps by a saline and confusedly formed efflorescence, which having looked upon through a glass, and also tasted, I guessed to be a kind of tartar. The like liquor, that the grains had afforded, had an acid taste, and would in the cold corrode coral; but the grains smelled somewhat musty. In all this time the verjuice had produced so little air, that we could scarce take notice of it by the mercurial gage, that had been shut up with it.

I INQUIRED of my lord of *Sandwich*, and a couple of gentlemen that accompanied him, whether it be true, which is reported of the purity of the air at *Madrid*, that though they have no houses of office, but every night throw out their excrements into

into the streets, yet by the next morning there remains no more smell of them. To which I was answered, that it was true the excrements were so disposed of, but that *Madrid* is the stinkingest town they ever came into; yet that it was difficult to discern in the morning any peculiar smell of what had been cast into the street by night: but they jointly affirmed, that the place, where the ambassador's numerous family resorted to make water in, did not smell of piss; and that they often observed the dogs and cats, that lay dead in the streets, were deprived of stench: and his lordship supposed, that the stench of a dead mule would in few hours vanish.

T I T L E XXVIII.

Of the Operation of the Air on the Odours of Vegetable Substances.

MAY 16. At the same time we opened another small receiver, wherein above three years before some large pieces of orange had been included: the rinds of these were much discoloured, their surfaces being almost black. They had scarce afforded any liquor, and yet we could not perceive the least mould in any of them, nor had they a putrid smell.

T I T L E XXIX.

Of the Operation of the Air on the Odours of Mineral Substances.

T I T L E XXX.

Of the Operation of the Air on the Tastes of Animal Substances.

HE answered me, that they could very well preserve meat, as beef, without salting it, as long as the frost lasted, that is, during the whole winter. But when it was once thoroughly frozen, they could not dress it so as to make it relish like good meat. Mr. Nickson.

T I T L E XXXI.

Of the Operations of the Air on the Tastes of Vegetable Substances.

T I T L E XXXII.

Of the Operations of the Air on the Tastes of Mineral Substances.

T I T L E XXXIII.

Of the Operations of the Air on the Colours of Animal Substances.

ENQUIRING of a man of letters, that had the curiosity to travel into the inland parts of *Brasil*, whether in that country the air had not a great influence upon the colours of clothes; he told me it had, and even upon black; infomuch that a kind of black taffety, which is the usual wear of the better sort, will, after it hath been worn a very few days, degenerate into an ironish colour: yet he answered me, that in the shops, where it is carefully kept from the air, the taffety continued of a good black.

NOR is it only upon the colour of stuffs, but of animals too, that he says the *Brasilian* air has an operation? for he says, that at a place 50 leagues beyond *Parigua*, there is a region, where white people do in a very short time grow basannez (or tawny) though a little way out of that particular region, as for instance beyond it, they quickly recover their wonted colour,

HE told me, that upon *Charleton* island they have flocks of certain birds, which the English there call partridges, though they resemble ours more in bulk than shape, being somewhat like wild pigeons, but a good deal bigger: these he says are white in the winter, and gray in the summer.

T I T L E XXXIV.

Of the Operations of the Air on the Colours of Vegetable Substances.

A LEARNED man, that was physician to the governor of *Jamaica*, being at his return asked divers questions by me, concerning that island, gave me, among others, the following answer. *Lignum vitæ*, said he, and most other trees at *Jamaica*, when they are newly cut down, wherever you cut the wood, that part, which is exposed to the air, will quickly grow green, though that which is a little beneath it be yellow, or of another colour; and this *lignum vitæ*, when green, is as soft as oak, or softer; and many other *Jamaica* woods, that are soft, when newly cut down, will afterwards so harden in the air, that ordinary tools will make no impression upon them; and the nails, that pierced them easily before, can no more be forced out of them; and this is chiefly conspicuous in the cabbage-tree, which being a wood soft enough when it is cut down, the pith, which is very copious, will quickly rot of itself, and the rest of the tree serves for a pipe of perhaps 100 foot long, that will not corrupt under ground, but grow almost as hard as iron.

ENQUIRING of an inquisitive traveller, what he had observed about the power of the air, which I had been informed was great, in working upon divers bodies at the island of *St. Jago*; he told me that he and his company had not stayed long enough there to make much observation of that kind; but, that seeing aloes growing plentifully there, they had gathered some plants of it, whose juice he found, as I have here in *Europe*, to be very clammy, and excessively bitter, and, which was wondered at, of a very dark colour; but having carried them in the ship towards the equinoctial, they found for a time the juice to be altered, having lost almost all its bitterness, and acquired a green colour.

STAINS of linen will best go out at the time of the year, when the fruits or plants, whole

whose juice made them, are in their prime: this a gentlewoman assured me she had tried in new linen stained with juice of quinces; and the lady *N. N.* affirmed, that she had particularly tried it in stains made with the juice of hops, which she says are the worst stains of all; and which having in vain tried to get out of her linen, she laid up her linen in her chest, and at the time of the year, when hops flourish, she found the stains vanish of themselves.

T I T L E XXXV.

Of the Operations of the Air on the Colours of Mineral Substances.

A CONSIDERABLE instance of the changes, that the contact of air is able to produce even upon solid minerals, I gave those, that saw it, by the following experiment. We took one part of lapis calaminaris, and about four parts of good salt-petre; these being well powdered and mixed, were put into a strong crucible, and kept in a vehement fire some hours, by which means the matter, as we expected, was alcalized: upon the thus prepared lapis calaminaris we poured a convenient quantity of fair water, which afforded us a solution, that was somewhat muddy, but appeared of a deep red: this we poured into a wide-mouthed glass, which we set in a window, that it might be the more accessible to fresh air. There, after a while, our darkish red solution turned quite green, and more diaphanous than before; but, continuing for some days to keep the glass in the same window (which respected the south) we found our green solution to lose its colour by degrees, and at last to be resolved into a transparent liquor, and a subsiding powder, that was not at all green, but red, or like brick-dust. These changes of colour succeeded in more than one parcel of our mineral solution.

WE took a very strong spirit of vinegar, and boiled it a while on crude filings of copper, without finding, that it was manifestly coloured by that operation, nor yet by letting it lye some hours in the same glass egg, wherein it had been boiled. Wherefore, supposing this want of colouration to depend upon the air's not co-operating in the best manner it might easily be made to do, we poured the liquor and the filings together into a broad flat glass (which we placed in a window shelving) so that though the filings were wet, yet but one part of them was covered to any depth by the menstruum. This done, we observed, as was expected, that the filings, exposed to the air, changed colour, and became of a greenish blue; whilst those, that were under the liquor, manifested no change of colour, but kept that, which belongs to copper, till the menstruum evaporating by degrees, they also being accessible to the air, acquired the same colour with the former vinegar. Q. Whether in a longer time the coloration would not have been made?

WE took some filings of copper, and divided it into two parcels; one we put into a flat and shallow glass with a wide mouth, and the other into a glass vial, whose neck was of the breadth usual to such vessels. Upon each of these parcels of filings we poured a convenient quantity of one and the same strong solution of sal armoniac made in fair water, and without covering each of the vessels, let them stand by one another for a competent time. Of which trial the event was such as was expected; namely, that the liquor in the vial was but faintly coloured, when that in the open glass, that had a large surface exposed to the free air, was very richly tinged. And this circumstance is not to be forgotten, that whereas all the lower part of the solution was of a deep blue, almost like ultra-marine, that part which was contiguous to the air, was covered over with a kind of film like thin ice, which was of a very differing blue, exceeding like that of the finer sort of turquoises.

WE

WE took two small parcels of filings of copper, and put each of them into a small piece of paper, with the edges turned upward, and then put upon each of them three drops of good spirit of sal armoniac. One of these papers we left in the window; the other we put into a small receiver, which, by help of our engine, was emptied in little more than a minute of an hour. At the end of two minutes, after the putting on of the spirit, there appeared a manifest blue on some parts of that paper, that was left in the window; but that, which was in the exhausted receiver, being deprived of the air, that should befriend its operation, continued there full a quarter of an hour or more (by a minute clock) without appearing to be at all coloured: wherefore taking off the receiver, we removed the paper to the same window, where the other stood, and within about two minutes it began to disclose a blueness, which within about two minutes more was considerably heightened.

INTO a slender vial, wherein we put a convenient quantity of the volatile or urinous spirit of the lees of wine (elsewhere by us described) which was of a yellow colour, we let fall some filings of copper; and stopping the glass well, we drew a tincture, which according to expectation was manifestly green, but not of the pleasantest and most transparent sort of green liquors: then suffering the vial to rest in a window for many days, we observed, that the liquor did then but slowly return to a yellow colour, which when it had acquired, without any mixture of greenness, we opened the vial for a very little while to let in the air, and then stopped it well again; the admitted air quickly began to change the surface of the liquor into a green colour; which, though slowly, extended itself downwards, till it had tinged the whole liquor. This colour afterwards, by long standing, did by degrees grow to a pale yellow.

THE 19th of *August* presented me with some phaenomena, that made me almost despair of reducing all those of our variable liquors to a settled theory. For coming that day at about ten a clock in the forenoon to a closet, where I kept several vials furnished with this liquor, I perceived one of them, that stood in the window, that had once almost quite lost its colour, to have re-acquired a very fair blue, at least as deep as that of the sky in a fair day. This vial I the rather watched, because I had taken notice, not without somewhat wondring at it, that for two days before, instead of losing, according to custom, the little remains of colour, that after many days standing it yet retained, the colour began again to increase, though the vial were constantly kept stopped as before; and that, which made this regaining of the colour seem more strange, was, that there stood just by it another vial furnished with the spirit, and with filings taken out of the same parcels, yet the liquor of this parcel continued colourless. Wherefore, suspecting, that some accident might have happened, whereby some little portions of air might have insinuated themselves thorough the cork of the altered liquor, I cast up my eyes to another vial, that stood in so high a place, that it was not easy to reach it, and where it had long rested, and lost its colour: but upon this view I was confirmed, that the change lately mentioned in one of the vials was not from the cork, but from some unobvious cause: for though this upper vial was furnished with a good glass stopple; yet the liquor it contained was again grown cæruleous, though the liquor of another vial, that stood just by it, continued colourless. Wherefore, to satisfy myself farther, I presently went to a private place where I had in a cavity made in the thickness of a wall set aside two vials, that several days before had quite lost their colour; and my former surprize was increased, when I found that one of them, which was stopped with a cork, continued colourless; yet the other that had a glass stopple, and stood just by it, had regained a fair cæruleous colour. Both these were fitted for trial, with the same spirit and filings, and the same day with the others abovementioned; and the heat of the weather had so little influence

ence upon this effect, that this day was remarkably cold, being made so by a northern wind, which made me observe it more so than I had found it for some time before.

I MUST not forget on this occasion, that I was invited by the foregoing phenomena, to look upon some spirit, not oil of amber, that I had kept in a vial for several days upon filings of copper, and had sometimes exposed to the air by unstopping the glass, and found, that though formerly the spirit kept its native colour better than I desired, yet it had acquired a green colour, which whether it will lose again by longer standing, time must determine.

THE slender vial, with spirit of honey, mentioned N°. the though it had been wont to exchange its yellow colour for a blue, by the contact of the external air in a very short time, and sometimes within a minute or two: yet being opened this afternoon, in the same place where it used to be so, did not in above an hour's time turn blue, but remained a transparent yellowish colour.

THE vial, with a glass stopple, mentioned N°. 945. being for divers weeks left unstirred in the window where it stood before, I several times observed it to lose and regain colour; and though sometimes it would only appear of a more faint or a more rich blue, yet sometimes also it would appear either quite or almost colourless, and, perhaps, in a day or two after, it would be again as blue as the sky. And this, though I could not find, that any thing in the weather was the true cause of this change, since the liquor would not only gain, but lose colour in colder weather; and so it would also do in warmer: but on Michaelmas day I found it to have attained a deep blue; and though since it has been now and then somewhat more dilute, yet during all the past month of *October*, I remember not to have seen it any thing mere colourless: and this day being the first of *November*, I found it to have resumed a high colour, though a vial with a glass stopple, which had for many weeks stood just by it, and formerly did divers times correspond with it in its changes, has continued all the last month of a very pale blue, without either deepning its colour, or growing quite colourless.

AN inquisitive gentleman of my acquaintance, being asked by me about a mountain in *Wales*, called where solid stones are said to change their colour very oddly, told me, that within sight of that hill, in a large piece of ground, that was then newly put under tillage, he saw good numbers of stones that looked like flints, and were full as hard, if not harder; the colour of most of them was dark, the rest gray: these stones, which, when the ground was newly turned up, were rust-coloured, he observed afterwards to grow lighter and lighter coloured; so that after three or four years, being invited by this observation to take notice of it at his coming to that place again, he found these stones almost all of them turned white. About which phenomenon, questioning the ancient inhabitants, with some expressions of wonder, they seemed to make little of it, and assured him, in the neighbouring mountain, almost all the stones, that were exposed to the air, underwent the like changes, and within a few years were blanched.

HAVING put some *mercurius sublimatus dulcis*, and *vitriolum Romanum* (tied up in several papers apart) into one box, at the end of twenty two months I found the sublimate mercury wholly changed into a substance so like antimony, that some not ignorant of the *materia medica* have taken it for the same; and the superficies only of the vitriol had acquired the same colour, but was not at all altered within. This from a credible relator.

T I T L E XXXVI.

Of the Air destroying or introducing other less obvious Qualities into Animal Substances.

T I T L E XXXVII.

Of the Air destroying or introducing other less obvious Qualities into Vegetable Substances.

AN intelligent gentleman, that stayed a year in *Guinea*, related to me, that he and his company found the great heat and moisture of the air to dispose bodies so to putrefaction, that he observed the white sugar to be sometimes full of maggots: and found, that divers drugs, salves, and other medicinal things that were brought with him, had quite lost their virtue; and some of them, especially ointments, were verminous. And he added, that in the island *St. Jago* (one of those of *Cabo-verde*) they laid store of sweetmeats upon tables to the heat of the sun, to dry up the superfluous moisture, which in strange abundance they had contracted the preceding night, which otherwise would quite spoil the sweetmeats, and bring them to putrify.

OXFORD, though seated for the most part of it on a gravelly hill, I have known to be very disagreeable to some moist splenetic and valetudinary bodies, whom I have heard complain, that they could not be so well there as elsewhere, especially in the spring; so that I take the air of that place to be generally moist. *Mr. J. T.*

AIR too dry, though sufficiently hot, is not favourable for the production of divers insects; for I have observed these two last dry springs, that there have been no soft garden-snails to be found abroad, and very few fleas bred in the house, which I impute to extraordinary long dryness of the air, for want of moist vapours to nourish them; since in wet summers we always swarm with snails, gnats, fleas, &c. whereas this year we have few or none.

T I T L E XXXVIII.

Of the Air destroying or introducing other less obvious Qualities into Mineral Substances.

Zwelfer,
pag. 800.

OBSERVANDUM etiam, quod antimonium diaphoreticum quocunque modo, sive cum solo nitro aut addito etiam tartaro, paratum sit, tractu temporis aeri expositum pravam & quasi malignam induat naturam, sumptumque intra corpus cordis angustias, cardialgias, lipothymias, vomitusque, & similia prava symptomata procreet, quæ facile tamen evitabimus, si vel singulis diebus vel tribus mensibus recenter illud conficiamus, vel jam paratum antimonium diaphoreticum vetustum, additâ portiunculâ nitri, aut etiam absque nitro, per unam vel alteram horam *Vulcano* tradamus, penitusque igniamus, iterumque, si nitrum additum fuerit, edulcoremus, & parumper reverberemus.

To prove, that it proceedeth from a natural cause, this one, though strange, yet true experiment, will suffice. Take of the earth of *Egypt*, adjoining to the river, and preserve it carefully, that it neither come to be wet nor wasted; weigh it daily, and you shall find it neither more nor less heavy until the 17th of *June*, at which day it beginneth to grow more ponderous, and augmenteth with the augmentation of the river, whereby they have an infallible knowledge of the state of the deluge, proceeding, without doubt, from the humidity of the air, which having a recourse through all passible places, and mixing therewith, increaseth the same as it increaseth in moisture.

A LEARNED physician of the college of *London* confessed to me, that he found by his own observation, that antimonium diaphoreticum, being kept some years, though in a covered vessel, acquired a vomitive quality, which it had not before; and that having long kept in a stopped glass a parcel of his own cerus of antimony, of which he used to give 12, 15, or more grains, without finding it emetic; he found, that in process of time it was so degenerated, that when he gave four or five grains, it would cause vomits.

EARTH laid up together in the air, for four, five or six years, does make far better pots for closeness, and holding of the fire, than that, which has lain but one season above ground, though that itself be much better than that, which is newly dug up, which will be very apt to crack in the fire, or when it comes to wet; as also those bricks, that lye at the top of the furnace, and therefore are not so thick covered as they burn, and are apt to deceive builders, when they come to be exposed to the rain and weather.

Purchas's 2d part, lib. vi. cap. 8. A vulgar experiment generally affirmed, as by Alpinus in Med. Egypt. lib. iv. cap. 8. who long lived here upon the testimony of Paulus Mucilius, the French consul, Baptiste Elianus a Jesuit, and John Varot an Englishman.

T I T L E XXXIX.

Of the Air in Reference to the Propagation and Vegetation of Plants.

AN ingenious traveller, that frequented the Pyrenean mountains, especially that, which many count the highest of them, and is known by the name of *Pic de Midi*, affirmed to me, that he, as well as several others, had manifestly observed a scarce credible difference between that side of those mountains, that regards *France*, and that, which reaches to *Spain*: for at the same time the former was verdant and flourishing, and yielded a delightful prospect to the traveller, as well as plentiful provisions to the inhabitants; the Spanish side of the hills was parched, and russet, and barren, and looked dismally, like a wilderness: which great difference of countries, observable in the same hills at the same time of the year, he imputed to the fierce, parching, and sometimes blasting winds that beat upon the Spanish side, and made that look so squalid, whilst the hills, that suffered this mischief on one side, did by their height check these hurtful winds, and skreening from them the French side of the mountains, left them to enjoy advantages, that the soil and climate furnished them with.

T I T L E XL.

Of the Air in Reference to the Generation, Life, and Health, of Animals.

DE vita igitur ac morte, & iis pene omnibus, quæ huic considerationi affinia sunt, dictum Aristot. de est. De sanitate verò morboque non solum medici, sed & physici est, causas quadantenus referre. Quatenus verò hi differant, & quatenus diversa contemplantur, ignorare

Aristot. de Respirat. cap. 21. & parag. 37.

non convenit. Equidem quòd confinis sit quadantenus hæc medici physicique tractatio, & res ipsa testatur. Nam & medici, quicunque paulò elegantiores & diligentiores sunt, de natura dicunt, & artis sua principia inde sumere dignantur; & physici omnes fere, qui cinnitalis aliquid habent, tractationem naturæ usque ad medicinam persequuntur.

AUGUST 13. The temperature of the air, both as to salubrity and other regards, may be derived as well from the subterranean steams, as the superficial effluvioms of the earth, and both these sorts of steams being variously transported and shuffled, and compounded by the winds and other motions of the air, upon the mixtures of them, the local qualities of the air, in differing places, may be supposed to result.

ABOUT three months before the late great plague began in *London* (in the year 1665) there came to Dr. M. a patient of his, to desire his advice for her husband; and the doctor having inquired what ailed him, she answered, that his chief distemper was a swelling in his groin, and upon that occasion added, that her husband assured her of his being confident, that the next summer the plague would be very rife in *London*: for which prediction he gave this reason, that in the last great plague he fell sick of that disease, and he then had a pestilential tumour; so in two other plagues, that since happened, though much inferior to that great one, each of them had a rising in his body to be its forerunner; and now having a great tumour in the forementioned place, he doubted not but it would be followed by a raging pestilence, which accordingly ensued. Having heard much talk of something of this nature, as related by the doctor, I enquired of him how much of it was true, and received for answer the foregoing narrative.

You did not perhaps expect, that the mere local motion of the air should be mentioned by me among the causes of the effects of its changes: and indeed the phenomena I have yet met with reducible to this kind have been but very few, notwithstanding which I shall take notice, that this local motion may in certain cases operate on other bodies, either as it turns the air into a wind, or as the tremulous motion of the air is modified into sound, or as the air is put into a vehement and disorderly motion by thunder.

As to the first of these it is evident, that upon the vehemence or slackness, and the places whence and where the changing wind happens to blow, there may divers effects ensue, especially in animated bodies. And this not only as the wind is accompanied with cold and heat, or moisture, or dryness, but (to restrain ourselves to instances more closely pertinent to our present purpose) as the wind is flowing air, or an aerial stream, for only as such it may ventilate the places, through which it passes, and by expelling the stagnant air, and introducing other air, may contribute to many of those changes (especially as to the health of animals) that we see to depend upon the alteration of air, and perhaps among the more tender sort of animals, there may be found some, in which the motion of the external air, though excluded by walls and windows, may have a considerable and immediate operation: for I have learned by enquiry from some curious natives of *Languedoc* (where I had the curiosity to look after silk-worms, abounding in that province) that in case it happened, when the worms having eaten their fill began to dispose themselves to work their silken eggs; in case, I say, it then happened to be thundering weather, a great part of the worms, especially the less vigorous, would be destroyed.

He affirmed to me, that in some mines of above a thousand foot deep, he saw horses, that had been let down by ropes to the third part of the depth, that is, above a hundred yards; and that several of them died either in the letting down, or by the change of the air; yet several of them survived, and were employed about the engines

gines belonging to the mines, and seemed not to have any sensible inconvenience as to respiration, though in the receptacles they wrought in, they were furnished with air but from the groove, through which they were let down, and by a moderately big shaft.

AN ingenious traveller, that has had the curiosity to visit the mines of several countries, as *Bohemia*, *Saxony*, *Swedeland*, &c. answered me, that the deepest mine he saw in *Bohemia* was of about 2000 of our feet.

AN intelligent person, that was for many years consul of the English nation at *Tripoli* in *Barbary*; and at another time governor of the castle (called) of the Coast, belonging to the English African company in *Guinea*, being discoursed with by me, about the diseases incident to that very unhealthy place, and about the worms, that bred in men's legs, told me, that the great noxiousness of the air was not constant, but frequently ceased, and returned within no long compass of time; insomuch that all his men would continue in health for many days together, and then on a sudden divers of them would fall sick, especially of fevers and fluxes, that usually killed them in forty-eight hours or less.

DR. C. chief physician to the Russian emperor, confirmed to me, that being in *Russia* in the winter, when the frost was very hard, and the east or north-east wind blew cold, if he turned his face toward the wind, and walked against it, (which at other times he was wont, and took a delight to do) he found himself unable to fetch his breath, and almost stifled, as if the air were very thick, or rather a great stiffness brought upon the organs of respiration, whereby he was unable to move them as at other times, so that he was fain to turn his head from the wind, that he might be able to fetch his breath.

AN observing person being asked about a tradition of seamen, that the lice of Europeans die when the ships pass the line; answered me, that he did not find it to be true, as it is wont to be delivered; but this he plainly observed in several of our English, with whom he sailed, that all the lice quitted their bodies, and got up into their heads, whence they dispersed themselves again, when the ship had left the equator a pretty way behind it.

BUT I remember, that another acquaintance of mine, that divers times passed the equinoctial in Portugal ships, which used to go to the *Indies* well crowded with people, many of them more poor than cleanly, answered me, that he had heedfully observed those people's numerous lice to die away as they cross the line, though in no long time after the same sort of cattle would begin to molest them again.

HIS royal highness the duke of *York*, at his return out of *Scotland*, having been pleased to discourse with some of us, that had the honour to be then near him, of some observations he made in his journey, mentioned among other things, that agues were very unfrequent in *Scotland*, which yet that year were very rife over almost all *England*. This gave me afterwards the curiosity to inquire of a studious person, who is one of the chief of the Scottish nobility, what he knew about the unfrequency of agues in his country. To which his lordship replied, that as to quartan agues it was generally taken notice of, insomuch that when news was brought, that a gentleman, whom he named, fell sick of that disease, amongst them in the country it was looked upon as a strange and remarkable thing. And though divers persons bring quartans out of *England* to *Edinburgh*, yet they so seldom keep them long there, that a Scottish physician, whom he named to me, offered to lay five to one of the quick recovery of several patients of his, if they would make some reasonable stay in that city.

Roderici
Fons. de
Sanit. tu.
end. pag.
105, 106.

Aer autem corrigetur causa corruptionis ablata, & quod jam inductum est mali extinguendo: si igitur ex nimio humore aer putrescit, ignibus accensis, qui omni putredini remedio sunt, exsiccandus, sic ignes, per vias & domus fiant ex odoratis plantis, qualis Laurus est, Myrtus, Pinus, Cupressus, Rosmarinus, & reliquæ ejus generis, qua ratione pestem Athenis Hippocrates extinxit; vapores præterea maligni per aeram sparsi dissipandi sunt, id quod à magnis ventis fieri solet. Sic Olyssiponi, cum trium dierum ingens procella venisset, pestis extincta nuper, est & in Maroco ingens pestilentia vento quodam evanuit; qui veluti è fornace (adeo calidus erat) exire videbatur, aerem autem nos imitando ventos commovere poterimus; si bombardarum strepitus multos fieri curemus; si verò vapores ex paludibus ac stagnantibus aquis fieri videntur, eas resiccare aut novare oportet frequenter, maximè per æstatem. Renovantur autem novis supervenientibus aquis, quas è fluminibus per canales traducere oportet; aut siccandæ sunt factis rivulis & fossis, per quæ superfluant ad flumina; quod cum primus magnus Etruriæ dux Cosmus Pisis fecisset, & magna animi contentione nunc faciat Ferdinandus, factum est, ut saluberrimus ejus urbis aer per omne anni tempus sit redditus: verum si cadaverum inhumatorum multitudo aerem inficit, magna & profunda facta fovea sepeliantur; si ab immunditie, & excrementis, quæ per urbem & domos sparguntur, id quod, ut reor, Bizantii, & Olyssiponi, in causa est, cur pestis adeo sæviat, ac duret, mundare oportet omnia; viæ ac domus quotidie, vel saltem semel in septimanâ, repurgandæ.

1. JOH. Beguinus in Tyrocin. Chymic. Lib. II. cap. 13. Dignum admiratione est, quod quamvis in viciniâ Hydriæ comitatûs Goriciensis, ubi reperitur copiose mercurius, singulis ferè annis lues pestifera grassatur, illa tamen semper immunis ab hac manere soleat; idque viri provectæ ætatis se observasse, & à majoribus suis accepisse, miki sanctè confirmarunt. Hinc patet, mercurium esse summum omnis putredinis ac corruptionis alexipharmacum. 2. Michael Majerus in lusu de mercurio. Argentum vivum est plurimorum morborum alexipharmacum, & ut testantur quidam, ipsius pestis (cum eo loco, ubi mercurius effoditur, & tractatur, nunquam aut rarissimè hoc contagium grassetur) dummodò maneat in suâ propriâ naturâ, & non à salibus aut aquis corrosivis inficiatur, ac venenosus redatur.

A VERY ingenious physician, that travelled much in the *East-Indies*, and visited some islands in the *South Sea*, to which our English were not permitted to have access, being asked of me some questions about the effects and changes of the air in those parts, related to me, that having made some stay in the famed island of *Ternate*, he learned, that the Dutch (who had mastered the inhabitants) did, upon a composition made with the king for his damages, cut down almost all the numerous clove-trees, that grew in that island, that thereby they might keep up the high rate of that spice, as indeed they have done. Whereupon there happened a change in the temperature of the air, that gave cause to conclude, that the exhalations of the blossoms which (being dried) afford the cloves, were not only very pleasant, but very healthful too: for no long time after the excision of these fragrant trees, the island became very unhealthful, which this physician very probably imputed to the corrosive and noxious steams, which plentifully issuing out from a kind of vulcan, or smoking, and sometimes burning hill, depraves the air of that island that is but little, but had their hurtful effects formerly prevented by the aromatic and benign emanations of those numerous blossoms and trees, that richly impregnated the air, and by their volatile and oily salts, opposed and hindred the effects of the sulphureous and other sharp steams of the vulcan. And my relator assures me, that this change of the air's constitution was so remarkable and acknowledged, when he was there, that whereas formerly sick and valetudinary persons used to be sent thither from *Batavia* to recover their

their health by the goodness of the air (as we often send consumptive persons into France) the air at his being in Ternate had been for divers years so unhealthful, that the Dutch were fain (from Batavia, or other more healthy places) to send men twice a year to relieve the garrisons, and bring back the many sick they usually found at their arrival in that formerly healthy island.

AN observing physician lately returned from Tangier, answered me, that though otherwise it be a healthy place, he took notice, that it was not unusual for new comers to find themselves feverish for many weeks, or some months after their arrival, especially if the piercing easterly wind happened to reign. This, he says, he found in himself, not only by a constant heat and some other symptoms, but by that main one of the preternatural quickness of his pulse. He added, that this disease, though very mild, held him near four months; when the easterly winds happened to blow, on which his feverishness so depended, that he could easily, when he awaked in the morning, know, without asking, whether that wind blew or not.

MAY 16. We put into a small receiver five or six little ants, which ran about very briskly; but the air being pumped out, they presently lost their motion, which they soon recovered upon the restoring of the air to them. Then the air was again withdrawn, and the insects thereby brought to lye (some upon their backs) as stark dead: in which condition they were suffered to remain about five or six hours; after which the air being let in upon them, they nevertheless continued seemingly dead for many minutes, (as we guessed between 15 and 30) but at length all recovered, running nimbly up and down the glass, though it were late at night.

Si patrono queste barche dalla costa della pescaria, è vanno all' isola di Ceilam, nella costa della quale per la lunghezza di venti miglia, tre sole miglia lontane da terra, sette braccia abbasso arrivando sino alli dieci nel fondo, si ritrova infinita quanta di madreperle, escono per questa pesca la barche la mattina col vento di terra, & arrivando al posto delle madreperle, gettare l'ancore, è fermarsi in quel posto, cominciano à tustarsi nel mare à marinari, de quali ogni barca ne ha quindici, è venti, è ciascuno di essi lega nel mezzo, con una fune, della quale ha cura uno, che resta in barca è con un'altra fune legandosi una pietra alla gamba, un'altro ha pure cura di quella, e cingendosi un' sacco di cuoio dinanzi, mettendosi le guante alle mani, così legato si tusta con violenza nel mare, lentando quelli le funi, è col peso della pietra, va con grandiss' violenza giu, & arrivato ch' è sciolta la gamba quella fune, con la quale sta legata la pietra, resta egli libero, & la pietra viene subito tirata sopra da quello, che n'ha cura, et il marinaio poi comincia con molta sollecitudine à pigliare quelle madreperle, che li vengono dinanzi, e le mette nel sacco, e sentendosi mancare la respiratione, tocca la fune, con la quale sta legato nel mezzo, e quello subito con grandiss' velocita lo tira et arrivando nella barca, scaricando le madre perle ripiglia fiato, è dopo torna a legarsi di nuovo la pietra, e di nuovo si tusta come sopra's è detto, e sempre così per tutta la giornata. Et e tanto faticosa questa pesca, ch'essendo, tanto profunde le madre perle nel mare, molti mancando loro la respiratione si trovano affogati.

Relatione della Provincia di Malavar. pag. 64 & 65.

It is, by long observation and often repeated experience, found certain, that if any foreigner lye on shore all night at Johanna, they seldom miss to be taken with sickness there, or within a few days after their departure from the island, and are commonly seized with putrid fevers, whereof most die in two or three days, though those, that have remained upon the place all day long, for several days together, are almost always safe, if they go on board of ship every night about a mile, or a little further from the shore. The island abounds with the greatest variety of plants and trees, that can be almost imagined in that circumference, and is generally excessive hot in the day time, but cold after sun-set. Whence it may possibly be supposed,

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ed, that the most volatile parts of those promiscuous (and probably many of them poisonous) plants, exalted in the day time by degrees, and suddenly condensed at night, may by inspiration infect the mass of blood much after the same manner as in pestilential airs. The inhabitants themselves are very much subject to fevers, (of what sort I could not learn) for which they cut or scarify their breast or abdomen in several places: but they observe, that few live, except their fever terminates in a considerable number of botches in divers parts of the body. There is one hill there remarkable for height, which is seldom or never free from thick fogs or clouds hovering over the top of it, sometimes higher, sometimes lower, according as the weather alters.

UPON the coast of *Cormandell*, and most maritime places of the *East Indies*, there are sometimes (I think yearly) fogs so thick (notwithstanding it is then very hot) that all, or most inhabitants from other nations, and the tenderer sort of the natives, are necessitated to keep their houses, with the doors and windows fast shut, there being little or no commerce at that time.

AT *Balassore* in the bay of *Bengale*, and in divers other parts in that country, there happens, after great rains, so great corruption of the air, that the stinking smell is very nauseous to the inhabitants; which I presume may be chiefly occasioned by a great number of frogs, and other reptiles (wherewith those places abound) left upon the dry places after the inundation, and then putrified by the excessive heat of the sun. At this time there is great sickness and mortality amongst the natives, chiefly by violent fevers.

IN the return of English ships from the *East Indies*, they generally put their sick people on shore at *St. Helena*, where they find so sensible alteration, that although carried thither, there are few, that do not recover so much strength, as to walk about in two or three days, which, in all probability, must chiefly be attributed to the alteration of air, not of food, there being in most ships much the same benefit of fresh provision for those, that are diseased.

Le chemin plus court de Mosul a Bagdad est par la Mesopotamie; mais on n'y trouve aucun village, & le Samiel y regne toute l'été depuis Mosul jusques à Sourat; ce qui oblige à prendre l'eau sur le Tigre, où ce vent ne souffle point. Le nom de ce vent est composé des mots, sam et jel, c'est à dire poison et vent, comme qui diroit vent de poison. Ce pourroit être le vent urens, dont parle Job xxvii. 21. Lorsque quelqu'un a respiré ce vent, il tombe mort subitement, quoi qu'il en ait quelques uns, qui ont le temps de dire qu'ils brûlent au dedans. D'abord qu'on est mort, on devient tout noir, et si on tire le mort par le bras, où par la jambe, où par un autre endroit, la chair quitte les os, et reste entre les mains de ceux, qui la touchent. Thevenot dans le bibliotheque universel: Tom. XIII. p. 266.

DOCTOR *Collins* relates, that in *Muscovy* their horses are much subject to a very scurvy disease, whose Russian name I have forgot, from which the natives are wont to preserve them, by keeping goats in their stables: and being asked by me, whether he had this by tradition, or upon his own trial? he affirmed, that he had found it true himself, and that he therefore was wont to keep goats in his own stable.

THE ingenious Mr. *Rycaut*, English consul at *Smyrna*, being asked of me, whether at *Smyrna* as well as at *Aleppo*, he observed, that the plague, that uses to rage in the former part of the summer, degenerates into other diseases about the latter end of *June*, and beginning of *July*; he answered me, that at *Smyrna* the observation does not hold so much as at *Aleppo*; but yet at *Smyrna* they generally observe, that about that time of the year, though exceeding hot, the malignity of the plague does

notably

notably lessen, for it is not quite so infectious, nor near so generally mortal, as it was in the former part of the summer. When many years ago I heard of this strange phænomenon of the pestilence at *Aleppo*, I began to think, whether a possible, though not perhaps the true cause of it may not be such as this; that the pestilential corpuscles, that rove up and down in the air, during the former part of the summer, require such a bulk or grossness to enable them to exercise their pernicious operations; but when the weather grows to be exceeding hot, that heat of the air becomes able to dissipate those corpuscles, and deprive them of that bulk, that we have supposed necessary to their destructive efficacy. For illustration of this conjecture, we may take notice of the smoke, that issues out of the weak of a candle newly blown out; for whilst the sooty-corpuscles retain their bigness and texture, they are able to offend the nostrils very much by their stink, and sometimes to cause convulsive motions and abortions in teeming women: but if you apply a flame to this smoke, it presently discusses this fuliginous matter, and dissipates it into particles of quite another nature, which by this means are deprived of all their offensive smell, and some other ill qualities. It may also be said, that the great increase of heat in *July* may enable the sun beams, by penetrating the earth deeper, and agitating its lower parts stronger, and producing crevisses, and other new or formerly obstructed passages in the upper parts of it, may elevate into the air divers saline and other new corpuscles, which may either divide or dissipate the pestilential ones, or else by associating themselves with them, make up new concretions, differing from the pestilential corpuscles, in bulk, shape, texture or motion, in most or all of these, by which means the morbid corpuscles being much altered, their operations on the human bodies they invade may be so too, and the diseases they produce may become less malignant, or degenerate into some other disease. And if it be demanded, why this does not happen elsewhere as well as at *Aleppo* and *Smyrna*? it may be answered, that the concurrence of causes may not be the same, and particularly, that the soil of those two places may be peculiarly disposed to emit pestilential corpuscles of such a determinate nature, with such a degree of heat, and dissipable by a greater, or with a more intense heat, to afford also exhalations capable to correct the former, as it is delivered by good authors, and ingenious men have confirmed it upon their own observation, that yearly, at grand *Cairo*, in the heat of summer the plague ceases to be mortal, and almost to be infectious, when the *Nile* begins to overflow; which wonderful change I should not so much ascribe to a frigeration of the air, that usually accompanies the swellings of the waters, (since pestilences rage in much cooler weather, than can be supposed in so hot a climate as that of *Egypt* in *July*) as to some nitrous and other corrected exhalations, that are plentifully emitted by the freshly arriving waters.

THERE is an account, that has not, that I know of, been taken notice of, upon which the supervening coldness and heat of the air may *pro tempore* very much alter the qualities of it, in reference to the bodies and health of men: for the air being a fluid body as well as water, and impregnated with salts of different kinds, some merely saline, and others associated with sulphureous and other kinds of particles; it seems not improbable, that what happens in that grosser fluid water, impregnated with differing sorts of salts, and altered by succession of heat and cold, takes place also in the air. I purposely tried in water, that by dissolving in it convenient quantities of two differing salts, though whilst the liquor was hot, or perhaps so much as luke-warm, they would swim together undistinguishably in the liquor, and so were in a capacity to act jointly, and, as the schools speak, *actione communi*, on divers occasions; yet when the liquor was cold, and sometimes when there was only a considerable remission of the heat, the saline particles of one kind, being not capable of being any longer

sufficiently agitated by so faint a degree of heat, would convene into grains or crystals; and losing their fluidity and motion, visibly separate themselves from the other kind of salts, which yet continued fluid in the water, where it could now act but by its own particular qualities, and not as formerly, *actione communi*.

THE clearest instance I found of this observation, was afforded me by an experiment made with the solutions of alum and nitre; a relation of which I find among my adversaria, in the following terms.

EQUAL parts of alum and nitre being dissolved in the same portion of fair water; and the liquor being in good measure evaporated, the earthen vessel, that contained it, was set in the cold, by which means, at the bottom and the lower part of the sides, the alum appeared to be first coagulated in many octaedrical grains, no crystals of nitre yet being visible. Afterwards, upon a further evaporation of the water, and the removal of the vessel from the fire, there appeared more grains of alum, but as yet no nitre: wherefore having yet further evaporated the liquor, at length the nitre shot plentifully into fine little crystals of the shape proper to that salt.

THIS is the account my note-book contains of this trial, which seems to invite us to conjecture, that of the numerous sorts of saline corpuscles, that rove up and down in the air, whilst it is well heated by the sun, or other causes, some sorts may, by the absence of that heat, or some supervening causes of coldness, be made to separate from the others, which were thereby contempered, or perhaps enabled to co-operate to divers purposes, that they were not fit for alone; and to form concretions, which, though not singly visible, may be too great to be kept in a state of fluidity by the diminished heat of the air.

A MOUSE lived ten minutes at least with a quarter air, and three afterwards.

T I T L E XLI.

Of heavy Bodies sustained in or taken up into the Air.

T I T L E XLII.

Of Dew.

T I T L E R XLIII.

Of Rain.

AN eminent virtuoso informed me, that in the country of *Campen*, he had seen divers pits, that are digged for turf, or rather peat, which were not deep for the most part, but reached to a kind of quick-sand, upon which the rain falling did by degrees, in some years, form a kind of slimy earth or clay, which was much of a martial nature; and being skilfully handled, would yield good iron.

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THE same person assured me, that he had divers times distilled the water of *Campan* in new and fine glasses, and still found them to leave a considerable quantity of stony matter at the bottom, notwithstanding the rectification.

Quicquid erit, sine fuco significat, velut Rottenberg, Silesiæ compastum appellant, perinde L. I. c. 8. Milessow temporum prognostes jure merito dici posset. Vidi ex proximo totum aliquando De Mont. montem densissimis nebulis contextum, eâ prorsus imagine, qua mons Sinai Moyse in nebula la- Bobemia, tente depingitur, at cæteri circum montes innubes & hilares, velut rerum gerendarum ignari, A Milessow montem stabant, sol ipse formosissimus ibat; at accolæ locorum domum fugiebant, pecora urgebant, temporum meque, ut domum protinus reciperem, properarem, & equos currum trabentes concitari ju- prælagia berem, monebant, neque horæ quadrans intercessit, jam cælum obduci, sol contegi, eripi capiuntur. omnis aspectus.

VIRG. *Immensum cælo ruit agmen aquarum;
—ruit arduus æther,
Et pluvia ingenti sata læta, boûmque labores.
Diluit, implentur fossæ,*

& quæ divinus poeta prosequitur. At contra etiam accidere vidi, ut cæteri fumârint montes, Milessow nihil se commovente, nihil aut nubilum aut turbidum minante; incolæ rogati, nihil esse magnopere timendum à cæteris spondebant, hunc unum intuendum esse, horum nubila omnia à Milessow quodammodo devorari.

T I T L E XLIV.

Of Hail.

ON écrit de Pisse en Flandres le 25 May, style nouveau, qu'il tomba dans cette ville la une graille, dont les moindres grains estoient comme des oeufs de pigeon. Cet orage a passé sur la citadelle & la ville, & n'a pas laissé une vitre entiere du coste du vent: les maisons sont toutes decouvertes, & les arbres rompus, les bleds coupez, & les perdrix & les lievres morts. On a pesé plusieurs grains de cette graille, dont les uns estoient d'un quarteron, de demi livre, de trois quarterons, et les plus gros d'une livre, & davantage. Il y en avoit un entr' autres, qui avoit dans le milieu une espece de matiere brune, qu'on mit dans le feu, qui fit faire un grand bruit. Il y en avoit un, qui estoit diaphane, lequel estant mis aupres du feu, fondit tout aussi tost comme du plomb, quoy qu'il fut beaucoup plus dur que les autres.

T I T L E XLV.

Of Snow.

T I T L E XLVI.

Of other Things falling out of the Air.

*E*O ipso anno, quo dux Eboracensis postremo rediit è Scotia Londinum, depluere tanta copia pisciculi balecibus colore, figurâ, sapore quam simillimi, in superiore Gallocidiæ in Scotia parte non procul à mari, ut duo terræ jugera ad Robertum Murray de Brughton equitem pertinentia nunc Londini, ut audio, degentem, cooperuerint. Rem autem totam serenissimo duci Eboracensi prius de eadem ab eo interrogatus, quod tum certior ab aliis de hac pluvia factus esset, tanquam testis oculatus, ut qui aliquos horum pisciculorum videram, confirmavi: is porro ingeniosissime, summâque veri specie nodum ita solvit, ut diceret hos pisciculos unâ cum aquis furentium ventorum gyro in turbinem actis evectos esse nubes, è quibus non procul inde pondere rursus suo relapsi fuerint in vicinam terram.

T I T L E XLVII.

Promiscuous Experiments and Observations of the Air.

T I T L E XLVIII.

Desiderata in the History of the Air, and Proposals towards supplying them.

GENERAL HEADS
FOR THE
NATURAL HISTORY
OF A
COUNTRY, Great or Small;

Drawn out for the Use of

TRAVELLERS and NAVIGATORS.

Printed first in the *Philosophical Transactions*, No. XI. p. 186. No. XVIII. p. 315. and No. XIX. p. 330. and afterwards reprinted with *other Directions for Navigators by another Hand*, at London 1692, in 12mo.

THE things to be observed in such a history, may be variously (and almost at pleasure) divided: as into supraterraneous, terrestrial, and subterraneous, and otherwise; but we will at present distinguish them into those things, that respect the heavens, or concern the air, the water, or the earth.

1. To the first sort of particulars belong the longitude and latitude of the place (that being of moment in reference to the observations about the air, &c.) and, consequently, the length of the longest and shortest days and nights, the climate, parallels, &c. what fixed stars are, and what not seen there; what constellations it is said to be subject to; whereunto may be added other astrological matters, if they be thought worth mentioning.

2. ABOUT the air may be observed its temperature, as to the first four qualities (commonly so called) and the measures of them; its weight, clearness, refractive power; its subtlety or grossness: its abounding with, or wanting an esurine salt; its variations according to the seasons of the year, and the times of the day; what duration the several kinds of weather usually have; what meteors it is most or least wont to breed; and in what order they are generated; and how long they usually last: especially, what winds it is subject to; whether any of them be stated and ordinary, &c. what diseases are epidemical, that are supposed to flow from the air: what other diseases, wherein that hath a share, the country is subject to; the plague, and contagious sicknesses: what is the usual salubrity or insalubrity of the air; and with what constitutions it agrees better or worse than others.

3. ABOUT the water may be observed the sea, its depth, degree of saltness, tides, currents, &c. Next, rivers, their bigness, length, course, inundations, goodness, levity (or their contraries) of waters, &c. Then, lakes, ponds, springs, and especially mineral waters, their kinds, qualities, virtues, and how examined. To the waters belong also fishes, what kinds of them (whether salt or fresh-water fish) are to be found in the country; their store, bigness, goodness, seasons, haunts, peculiarities of any kind, and the ways of taking them, especially those that are not purely mechanical.

4. In the earth may be observed,

1. Itself.

2.

2. Its

2. Its inhabitants, and its productions, and these external, and internal.

FIRST, in the earth itself may be observed its dimensions, situation, east, west, north and south; its figure, its plains and valleys, and their extent; its hills and mountains, and the height of the tallest, both in reference to the neighbouring valleys or plains, and in reference to the level of the sea: as also, whether the mountains lye scattered, or in ridges; and whether those run north and south, or east and west, &c. what promontories, fiery or smoking hills, &c. the country hath, or hath not; whether the country be coherent, or much broken into islands: what the magnetical declination is in several places, and the variations of that declination in the same place (and, if either of those be very considerable, then, what circumstances may assist one to guess at the reason, as subterranean fires, the vicinity of iron mines, &c.) what the nature of the soil is, whether clay, sandy, &c. or good mould; and what grains, fruits, and other vegetables, do the most naturally agree with it: as also, by what particular arts and industries the inhabitants improve the advantages, and remedy the inconveniencies of their soil: what hidden qualities the soil may have (as that of *Ireland*, against venomous beasts, &c.)

SECONDLY, above the ignobler productions of the earth, there must be a careful account given of the inhabitants themselves, both natives and strangers, that have been long settled there: and in particular, their stature, shape, colour, features, strength, agility, beauty (or the want of it) complexions, hair, diet, inclinations, and customs that seem not due to education. As to their women (besides the other things) may be observed their fruitfulness or barrenness, their hard or easy labour, &c. and both in women and men must be taken notice of what diseases they are subject to, and in these whether there be any symptom, or any other circumstance, that is unusual and remarkable.

As to the external productions of the earth, the enquiries may be such as these: what grasses, grains, herbs (garden and wild) flowers, fruit-trees, timber-trees, (especially any trees, whose wood is considerable) coppices, groves, woods, forests, &c. the country has or wants: what peculiarities are observable in any of them: what soils they most like or dislike, and with what culture they thrive best. What animals the country has or wants, both as to wild beasts, hawks, and other birds of prey; and as to poultry, and cattle of all sorts; and particularly, whether it have any animals that are not common, or any thing that is peculiar in those that are so.

THE internal productions or concealments of the earth are here understood to be the riches, that lye hid under the ground, and are not already referred to other enquiries.

Among these subterranean observations may be taken notice of, what sorts of minerals of any kind they want, as well as what they have; then, what quarries the country affords, and the particular conditions both of the quarries and the stones; as also, how the beds of stone lye, in reference to north and south, &c. what clays and earths it affords, as tobacco-pipe-clay, marls, fullers-earths, earths for potters wares, boluses, and other medicated earths; what other minerals it yields, as coals, salt-mines, or salt-springs, alum, vitriol, sulphur, &c. what metals the country yields, and a description of the mines, their number, situation, depth, signs, waters, damps, quantities of ore, goodness of ore, extraneous things, and ways of reducing their ores into metals, &c.

To these general articles of enquiries (saith their proposer) should be added, 1. Enquiries about traditions concerning all particular things relating to that country, as either peculiar to it, or at least uncommon elsewhere. 2. Enquiries, that require learning

ing or skill in the answerer: to which should be subjoined proposals of ways, to enable men to give answers to these more difficult enquiries.

WHAT is the proportion of salt, that is in the water of differing seas? and whether in the same sea it be always the same? and if it be not, how much it differs?

WHAT is the gravity of sea-waters in reference to fresh waters, and to one another; whether it vary not in summer and winter, and on other scores? and whether in the same season its gravity proceed only from the greater or lesser proportion of salt that is in it, and not sometimes from other causes? and what are the differing gravities of the sea-water, according to the climates*.

WHAT are the odors, colours and tastes, observable in sea-water?

WHAT is the depth of the sea in several places, and the order of its increase and decrements? and whether the bottom of the sea does always rise towards the shore, unless accidentally interrupted?

OF the bottom of the sea, and how it differs from the surface of the earth, in reference to the soil, and evenness or roughness of the superficies; and the stones, minerals and vegetables to be found there?

WHAT the figuration of the seas from north to south, and from east to west, and in the several hemispheres and climates?

WHAT communication there is of seas by streights and subterranean conveyances?

OF the motion of the sea by winds, and how far storms reach downwards towards the bottom of the sea?

OF the grand motions of the bulk or body of the sea; especially of the tides; their history as to their nature and differences.

WHAT power the sea hath to produce or hasten putrefaction in some bodies, and to preserve others; as wood, cables, and others, that are sunk under it?

OF the power ascribed to the sea to eject dead bodies, succinum, ambergrease?

OF the shining of the sea in the night?

WHAT are the medical virtues of the sea, especially against hydrophobia?

WHAT is its virtue to manure land? and what are the plants, that thrive best with sea-water?

The particulars whereof (saith the author) are here omitted; Sir Robert Moray and Dr. Wallis having by their more accurate inquiries about tides made them needless.

Articles of Enquiries touching Mines.

THE first, the neighbouring country about the mines.

THE second, the soil where the mines are.

THE third, the signs of mines.

THE fourth, the structure and other particulars belonging to the mines themselves.

THE fifth, the nature and circumstances of the ore.

THE sixth, the reduction of the ore into metal.

Queries about the first Title.

I. WHETHER the country be mountainous, plain, or distinguished with vales? And in case it be mountainous, what kind of hills they are; whether high or low, or indifferently elevated? Whether almost equal, or very unequal in height? Whether

* This last clause containing a difficult query, and that may seem something odd, Mr. Boyle thinks fit to note, that having recommended this matter, among others, to a learned physician, that was sailing into America, and furnished him with a small hydrostatical instrument, to observe from time to time the differences of gravity he might meet with; this account was returned him, that he found by the glass, the sea-water to increase in weight, the nearer he came to the line, till he arrived at a certain degree of latitude, as he remembers it was about the 30th, after which the water seemed to retain the same specific gravity, till he came to the Barbadoes or Jamaica.

fruitful or barren, cold or temperate, rocky or not; hollow or solid? Whether they run in ridges, or seem confusedly placed; and, if the former, what way the ridges run, north or south, &c. and whether they run any thing parallel to one another?

2. WHETHER the country be barren or fruitful? and, if any way fruitful, what it produces, and what it most abounds with?

3. WHAT cattle it nourishes, and whether they have any such thing peculiar in point of bigness, colour, shape, longevity, fitness or unfitness to make good meat, &c. as may be rather ascribed to the peculiar nature of the place, than to the barrenness of the soil, or other manifest causes?

4. WHETHER the natives, and other inhabitants, live longer or shorter than ordinary? Whether they live more or less healthy? Whether they be subject to any epidemical diseases, that may very probably be imputed to the mines; and what these diseases are, and what remedies are found successful?

5. WHETHER the country be or be not furnished with rivers, brooks, springs, and other waters; and how these waters are conditioned?

6. WHETHER the air be dry or moist, hot or cold, clear or foggy, thick or thin, heavy or light; and especially, whether the weather be more or less variable than ordinarily; or whether it be subject to great and sudden changes, that may probably be imputed to the mineral and subterraneous steams; and what they are?

About the second Title.

7. WHETHER the soil, that is near the surface of the earth, be stony; and, if it be, what kind of stones it abounds with? Whether it be clayey, marley, chalky, &c.? And, if it be of several kinds, how many they are; and by what properties they are distinguished?

About the third Title.

8. BY what signs they know or guess, that there is a mine in such a place?

9. THESE signs are either upon the surface of the earth, or beneath it.

To the former belong these queries.

10. WHETHER the ground be made barren by metalline or mineral effluvia?

11. WHETHER it be observed, that trees and other greater plants seem to have their tops burnt, or other leaves or outsides discoloured? or whether there be any plants, that do affect to grow over such mines; and whether it have been tried, that other plants, that would prosper in the adjacent places, will not be made to grow or thrive?

12. WHETHER the stones and pebbles, that are washed by the brooks, springs, or other waters, have any coloured substance left upon them; and if they have, of what colour, weight, &c. these adherences are?

13. WHETHER the waters of the place proposed do by their taste, smell, pondeusness, &c. disclose themselves to contain minerals? and, if they do, what minerals they or their residences, when they are evaporated away, do appear to abound with, or to participate of?

14. WHETHER snow will not lye, or frost continue so long, or dew be generated or stay upon the ground in the place proposed, as on other neighbouring grounds?

15. WHETHER the dew, that falls on that ground, will discolour white linen or woollen cloths, spread over night on the surface of the ground, and employed to collect the dew? And whether the rain, that falls there, and may be supposed to come thither from elsewhere, will discolour such clothes, or afford any residence of a mineral nature?

16. WHETHER

16. WHETHER the place be more than ordinary subject to thunder and lightning, and to sudden storms or earthquakes, as likewise to nocturnal lights and fiery meteors.

17. WHETHER mists use to rise from grounds stored with minerals? What is observable in them, and what minerals they signify, and may be supposed to be produced by?

18. WHETHER the virgula divinatoria be used to find out the veins of proposed mines; and, if it be, with what success?

19. WHAT other signs above ground afford probability of mines, or direction for following a vein over hills, vallies, lakes, rivers, &c?

THE second sort of signs belonging to these queries are such as follow.

20. WHETHER there be any clays, marles, or other mineral earths, yellow or liquid matters, that usually give notice of the ore? and if there be more than one, how, and at what depths, they are wont to lye respectively? Of what thickness and consistence they are; and in what order the diggers meet with them?

21. WHETHER there be any stones or marcasites to be found near, or not very far from the surface of the ground, by which one may have ground to expect a mine? As is often observed in the tin mines of *Cornwall*, over which such kind of stones are divers times found lying above ground.

22. WHETHER all stones of that kind do equally signify that mine? And, if not, how the significant stones are to be known, as by colour, bigness, shape, weight, depth under ground, &c?

23. WHETHER there be any earths of peculiar kinds, as to colour, consistence, &c. that indicate a mine beneath or near them; and if there be, what they are, and what is their consecution, if they have any?

24. WHETHER heat or damps give any assurance or a probability of finding a mine?

25. WHETHER water of any kind met with in digging, especially at this or that depth, do betoken a mine?

26. WHETHER there be any signs of the nearness of the mine, and what they are?

27. WHETHER there be any signs of one's having missed the mine, either by being past above, or beneath, or having left it on either hand, and what they are?

28. WHETHER there may be any signs, not only of the distinct and determinate kind of metals or minerals, but of the plenty and goodness of the vein, and what they are?

29. WHETHER there be any signs of the depth of the vein beneath the surface of the earth, and what they are?

30. WHETHER there be any proper or peculiar signs, that show it to be hopeless, or at least unlikely to find a vein in the place where it is digged for, and what those are?

About the fourth Title.

31. WHAT is the depth of the shaft or groove (which though named in the singular number, the questions about it are generally applicable) till you come at the vein or ore?

32. WHETHER the vein run, or lye horizontally, or dip? And, if it dip, what inclination it hath, how deep the lowest part lyes, and consequently how much deeper than the uppermost? As also, what its flexures, if it have any, are? And whether it runs directly north or south, east or west; or seem rather to have a casual tendency, than any determinate one by nature? And how far it reaches in all?

33. WHAT is the wideness of the groove at the top, and elsewhere? Whether
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the groove be perpendicular or crooked; and if crooked, after what manner, and with what distance it winds?

34. How the groove is supported? What are the kinds, length, bigness, and way of placing the timber, poles, &c. that are employed to support it? And how long the wood will last, without being spoiled with the subterraneous fumes and waters? And what wood lasts longest?

35. WHAT air-shaft belongs to the mine? Whether it be single or more than one? Of what breadth the air-shaft is at the orifice? Whether it be convenient enough, or not? How near it is placed to the groove, and in what position? And if there be several air-shafts, what their distances and situation are in reference to the groove, and to each other? Or how air is supplied, if there be no air-shafts?

36. WHETHER they meet with any waters in the mine? And, if they do, how copious they are; at what depths they occur, how they are qualified, and what way they spring, &c.?

37. WHETHER they are constant or temporary? whether they increase or diminish notably in summer or winter, or at any other time of the year, and if they do, at what season that is; how long it is wont to last; and the proportions of increase and decrease?

38. WHAT expedients and engines are employed to free the mines from water? The materials, the parts, the bigness, the shapes, the coaptation; and in short, the whole structure, number, and way of applying the instruments, that are made use of to free the mines from water?

39. WHAT are the conditions, number, &c. of the adits?

40. WHETHER the mine be troubled with damps, and of what kind they are; whether they come often or seldom at any set time, or altogether irregularly; what signs forerun them; what mischief they do; what remedies are the most successfully employed against them, as well in reference to the clearing of the mine, as to the preservation and recovery of the workmen?

41. WHAT methods the mine-men use in following the vein, and tracing their passages under ground (which they call plumbing and dialling) according to the several exigencies? And whether they employ the instruments, made with the help of the loadstone, the same way that is usual; and if not, wherein they differ in the use of the same instruments; or what instruments they substitute in their place?

42. WHAT ways they take to secure themselves from the uncertainty, incident to the guidance of magnetic needles from the iron-stone or ore, that they may meet with under ground? (of which yet perhaps there is not so great danger, as one may imagine; as far as I could find by a trial, I purposely made in a groove, where I was sure there wanted not iron ore.) And what other ways may be used to direct miners without the help of a loadstone?

43. How the miners deal with the rocks and spars they often meet with, before they come at the ore? Whether they use fire to soften, calcine, or crack them? How they employ it, and with what measure of success?

44. WHAT ways and cautions they use to free the mine and secure the workmen from the inconveniencies and danger accruing from the use of much fire in it?

45. WHAT instruments they use to break the rock, &c. And how those instruments are conducive, and how long they last?

46. How the mine men work, whether naked or clothed? And what lights they use to work by, what materials they are made of, what measure of light they give, how long they last? And by what ways they are kept burning in that thick and foggy air?

47. How veins are followed, lost, and recovered? And how several miners work

on

on the same vein? And what is the best way of getting all the ore in a vein, and most conveniently?

48. How they convey out their ore and other things, that are to be carried out of the mine? Whether they do it in baskets drawn up by ropes, or upon men's backs; and if this last-named way, what kind of vessels they use for matter, shape, and capacity? And whether the workmen delivered them one to another, or the same workmen carry them all the way? And whether the diggers descend and ascend by ladders of wood, or of ropes, &c.?

About the fifth Title.

49. WHETHER the ore runs in a vein, or lye dispersed in scattered pieces; or be divided partly into a vein, and partly into loose masses; or like a wall between two rocks, as it were in a clift, or be interspersed in the firm rock, like speckled marble? Or be found in grains like sand or gravel; as store of excellent tin is said to be found in some parts of *Cornwall* at the sides and in the channels of running waters, which they call; or whether the ore be of a softer consistence, like earth or loam, as there is lead ore in *Ireland* holding store of silver; and iron ore in the north parts of *Scotland* and elsewhere? And what is observable in it as to weight, colour, mixture, &c.?

50. WHETHER any part of the metal be found in the mine perfect and complete? (As I have had presented me good valuable copper, and pieces of perfect lead, that were taken up, the one at *Jamaica*, and the other by an acquaintance of mine, that took them out of the ground himself in *New England*.)

51. WHETHER the mine affords any parcels of metal, that seem to grow like plants? (As I have sometimes seen silver growing, as it seemed, out of stone, or spar almost like blades of glass; as also great grains of a metal, which appeared to me, and which those that tried some of it, affirmed to be gold, abounding in a stony lump, that seemed to consist chiefly of a peculiar kind of spar.)

52. WHETHER the vein lye near, or much beneath the surface of the earth, and at what depth?

53. WHETHER the vein have or have not any particular concomitants, or coats (if I may so call them;) and, if any, what they are, and in what order they lye? (As the veins of lead ore with us, have frequently annexed to them a substance called spar, and next to that another called caulk.)

54. WHETHER (besides these coats) the vein have belonging to it any other heterogeneous substance? As in tin-mines we often find that yellow substance, which they call mundick.)

55. WHAT are the principal qualities of these extraneous substances? (As that spar is white, but transparent, almost like coarse crystal, heavy, brittle, easily divisible into flakes, &c. Caulk is of a different texture, white, opacous, and like a stone, but much more ponderous. Mundick I have had of a fine golden colour; but, though it be affirmed to hold no metal, yet I found it in weight, and otherwise, to differ from marchasites: and the mine men think it of a poisonous nature.)

56. WHETHER the vein be inclosed every way in its coats, or whether it only lye between them?

57. WHETHER the vein be every way of an uniform breadth, and thickness; and, if it be, what these dimensions are; and, if not, in what places it varies, and in what measure? (The like questions are to be made concerning the spar, caulk, and other teguments or mixtures of the ore.)

58. WHETHER the vein be uninterrupted, or in some places broken off; and

whether it be abruptly or not; and whether it be by vales, brooks, gulleys, &c.

59. How wide the interruptions are; what signs whereby to find the vein again; whether the ulterior part or division of the vein be of the same nature, and hold on in the same course, as to its tendency upwards or downwards, or horizontally, northward, southward, &c. with the vein, from which it is cut off?

60. WHETHER, in case the last end of the vein be found, it terminate abruptly, or else end in some peculiar kind of rock or earth, which does, as it were, close or seal it up, without leaving any crack or cranny, or otherwise? And whether the terminating part of the vein tend upwards, downwards, or neither? And whether in the places, where the vein is interrupted, there be any peculiar stone or earth, that does, as it were, seal up the extremity of it?

61. WHETHER it be observed, that the ore in tract of time may be brought to afford any silver or gold, which it doth not afford, or more than it would afford, if it were not so ripe? And whether it have been found, that the metalline part of the vein grows so, that some part of the mine will afford ore or metal in tract of time, that did not so before? And whether to this maturation of the mine, the being exposed to the free air be necessary; or whether at least it conduce to the acceleration of it, or otherwise?

62. WHETHER all the ore contained in the mine be of the self-same nature and goodness; and, if not, what are the differing kinds, and how to be discriminated and estimated?

63. WHAT is the fineness and goodness of the ore, by which the mine is wont to be estimated? And what are the marks and characters, that distinguish one sort from another.

64. WHAT proportion of metal it affords? (As in our iron mines it is observed, that about three tons of iron stone will afford one ton of metal: and I have had lead ore, which an ingenious man, to whom I recommended such trials, affirmed to me to afford three parts in four of good lead.)

65. WHETHER the ore be pure in its kind from other metals, and, if not, of what metals it participates, and in what proportion? Which is especially to be enquired into, in case the mine be of a base metal, that holds a noble metal: (as I have known it observed, that lead ore, that is poor in its own metal, affords more silver than other: and I remember, that the ore lately mentioned, being rich in lead, scarce afforded us upon the cupel, an atom of silver. And *Matthesius* informs us, that a little gold is not unfrequently found in iron ore. And I have by me some gold, that never endured the fire, taken out of a lump of tin ore.)

About the sixth Title.

66. WHAT are the mechanic and previous operations, as beating, grinding, washing, &c. that are used to separate the ore from the heterogeneous bodies, and prepare it for the fire? Or whether the ore requires no such preparation? (as it often happens in lead, and sometimes in iron, &c.)

67. WHETHER mercury be made use of to extract the nobler from the baser metals? (as is their practice in *Peru*, and other parts of the *West Indies*.)

68. WHETHER the leaving the ore exposed to the open air and rain for a good while, be used as a preparative? (as I have seen done in iron stone.)

69. WHETHER the burning and beating of the ore be used to prepare it for the furnace? (as is practised in iron, and almost always in copper:) and in case they use more than once, how often they do it; (for copper ore is in some places washed eight or

or ten times, and in others twelve or fourteen) and with what circumstances: as how long the ignition lasts at a time, whether the ore be suffered to cool of itself, or be quenched? Whether it be washed betwixt each ignition?

70. WHAT flux-powders, and other ways they have to try and examine the goodness of the ore in small quantities?

71. WHETHER when they work in great, they use to melt the ore with any flux or additaments, or only by the force of the fire, or in any way between both? (as throwing in of charcoals, when they melt iron-stone, does not only serve to feed the fire, but perhaps by the alcali of its ashes to promote the fusion; so lime-stone, &c.)

72. WHAT kind of furnaces they use to melt the ore in, whether they be all of one sort and bigness, or if differing?

73. WHAT are the situation, materials, dimensions, shape, bigness, and in short, what is the whole structure and contrivance of the furnace? If there be any thing peculiar and remarkable? What tools are used in smelting, their figures, use, &c. and the whole manner of working?

74. WHAT kinds of fuel, and what quantities of it, are wont to be employed in the furnace, within the compass of a day, or week? How much is put in at a time? How often it is renewed? And how much ore in a determinate time, as a week, or a day, is wont to be reduced to metal?

75. IN case an additament be employed, what that is, and in what proportion it is added? Whether it be mingled with the ore, before that be put into the fire, or cast in afterwards, and if so, at what time, &c.?

76. WHETHER the ore be melted by a wind, excited by the fire itself, as in wind-ovens? Or by the course of waters? Or actuated by the blast of bellows; and if so, whether these bellows be moved by a wheel, turned by water running under it, or falling on it? And what are the dimensions, situation, &c. of the bellows?

77. WHAT contrivance they have to let or take out the metal, that is in fusion, and cast it into bars, sows, pigs, &c.?

78. WHAT clay, sand, or mould they let it run or pour it through? and after what manner they refrigerate it?

79. WHETHER or no they do either to facilitate the fusion, or to obtain the more or better metal, mingle differing sorts or degrees of ore of the same metal? As in some places it is usual to mingle poor and rich ore; and at *Mendip* they mix two or more of those differing kinds of lead ore, that they call frim-ore, steel-ore, potern-ore, &c.

80. WHETHER or no, having once brought the ore to fusion, they melt all the metal itself to have it the more pure? And, if they do, with what circumstances they make the fusion?

81. WHETHER they have any signs, whereby to know, whether the fusion have been well or ill performed; and the metal have obtained the perfection to be expected from such ore, melted in such a furnace?

82. WHETHER they observe any great difference in the goodness of the metal, that first melts, from that of the rest of the metal, which comes afterwards in the same or another operation? And whether the rule holds constantly? (For, though they observe in tin-mines, the best metal comes first; yet in the works of an industrious friend of mine, he informs me, that the best metal comes last.)

83. WHETHER the produced metal be all of the same goodness? And, if it be, how good it is in reference to the metal of other mines, or other parts of the same mine or vein? And, if it be not, what differences are observed between the produced portions of metal, and what disparity that amounts to in the price?

84. WHAT are the ways of distinguishing them, and estimating their goodness?

85. WHETHER

85. WHETHER they do any thing to the metal after it is once brought to a fusion, and, if need be, melt it over again, to give it a melioration? (as when iron is refined, and turned into steel,) and what distinct furnaces, and peculiar ways of ordering the metals, are employed to effect this improvement? With a full description of them and the tools in all circumstances, observed in the refining of metals.

86. WHETHER in those places, where the metal is melted, there be not elevated some corpuscles, that stick to the upper parts of the furnace, or building? And, if there be, whether they be barely fuliginous and recrementitious exhalations, or at least in part metalline flowers? (As in the Cornish tin-mines, after some years they usually destroy the thatched houses, where the ore hath been melted, to get the stuff, that adheres to the insides of the roofs, out of which they melt store of excellent tin.)

87. WHETHER the metal being brought to fusion affords any recrements? (As iron stone affords store of a dark glass or slag) and if it do, what those recrements are? How they are separated from the metal? And to what uses they are employed?

88. WHETHER, after the metal has been once melted, the remaining part of the ore being exposed to the air, will in tract of time be impregnated, or ripened, so as to afford more metal? (For this is affirmed to me of the Cornish tin ore; and what remained after the fusion of iron ore in the forest of *Dean*, is so rich in metal, that a tenant of mine in *Ireland*, though he had on the land he held from me, an iron mine, found it less profit to work it, than to send cross the sea to the forest of *Dean* for this already used ore, which having lain for some ages, since it was thrown aside in great heaps exposed to the air, he affirmed to yield as well great store of iron, as very good; though I somewhat doubt, whether this be totally to be ascribed to the air and length of time, or to the leaving of metal in the slags in old times, before great furnaces were in use.)

Promiscuous Enquiries about Mines, from the same Author.

1. WHETHER the territory, that bears the mine, abounds with no other kind of mineral in distinct parts of it? (As in *Kent* near *Tunbridge*, one part of the country which is hilly, abounds all along with iron-mines; the other, which is also hilly, and divided from it but by a small valley, abounds exceedingly (as the diggers and inhabitants told me upon the place) in quarries, which the metalline country wants, but is quite destitute of iron-stone. And so at *Mendip*, in one part of the hill, I saw store of lead-mines, containing several kinds of ore of that metal: another part of the hill I found to be full of coal pits, which had some marchasites, but no metal; and in another place, iron ore, and mixed with ores, which yet they did not think fit to work.)

2. WHETHER the air appear to be really cold in summer, and hot in winter at the bottom of the mines, by surer proofs than the testimony of our touch?

3. WHETHER they ever meet with places and stones actually very hot, as *Mattheus* relates? And whether that spring not from the quenching of marchasites?

4. WHETHER they find in the mines any mineral gelly, such as the German naturalists call *ghur*? And whether in process of time it will harden into a metal, or mineral concretion?

5. WHAT are the laws, constitutions, and customs, œconomical, political, ethical, that are received and practised among the mine-men?

6. WHETHER the diggers do ever really meet with any subterraneous demons; and if they do, in what shape and manner they appear; what they portend, and what they do, &c.?

7. WHETHER they observe in the trees and other plants, growing over or near the mine,

mine, not only (as hath been already intimated) that the leaves are any whit gilded or silvered by the ascending mineral exhalations, but also, that the trees or other plants are more solid and ponderous? And if they have not also some discernible metalline or mineral concretes, to be met with in the small cavities and pores of their substance?

8. WHETHER there be not springs, and also greater streams of water near the mine, that rise, and run their whole course under ground, without ever appearing above it?

9. WHETHER the subterraneous springs do rise with any wind or determinate change of weather?

10. How much heavier the atmosphere is at the bottom of the mine, than at the top? And whether damps considerably increase the weight of it?

11. WHETHER they find any strange substances in the mines, as vessels, anchors, fishes inclosed in spar or metal, &c.?

A

PAPER of the Hon. ROBERT BOYLE'S,

Deposited with the Secretaries of the Royal Society, *October*
14, 1680. and opened since his Death; being an Account
of his making the Phosphorus, &c.

Printed first in the *Philosophical Transactions*, No. CXCVI. p. 583. January
1692-3.

THERE was taken a considerable quantity of man's urine, (because the liquor yields but a small proportion of the desired quintessence) and of this a good part at least, had been for a pretty while digested before it was used. Then this liquor was distilled with a moderate heat, till the spirituous and saline parts were drawn off; after which the superfluous moisture also was abstracted (or evaporated away) till the remaining substance was brought to the consistence of a somewhat thick syrup, or a thin extract. This done, it was well incorporated with thrice its weight of fine white sand; and the mixture being put into a strong stone retort, to which a large receiver (in good part filled with water) was so joined, that the nose of the retort did almost touch the water: then the two vessels being carefully luted together, a naked fire was gradually administered for five or six hours, that all that was either phlegmatic or volatile might come over first. When this was done, the fire was increased, and at length for five or six hours made as strong and intense as the furnace (which was not bad) was capable of giving: (which violence of fire is a circumstance not to be omitted in this operation.) By this means there came over good store of white fumes, almost like those, that appear in the distillation of the oil of vitriol; and when those fumes were passed, and the receiver grew clear, they were after a while succeeded by another sort, that seemed in the receiver to give a faint bluish light, almost like that of little burning matches dipped in sulphur. And last of all, the fire being very vehement, there passed over another substance, that was judged more ponderous than the former, because it fell through the water to the bottom of the receiver; whence being taken out, (and partly even whilst it stayed there,) it appeared by several effects and other phaenomena, to be such a kind of substance as we desired and expected.

A N

A N
A C C O U N T
O F T H E

Honourable ROBERT BOYLE's Way of examining
W A T E R S, as to Freshness and Saltness.

To be subjoined as an Appendix to his lately printed Letter about the sweet-
ned Sea-Water, *October 30, 1683.* *

Printed first in the *Philosophical Transactions*, No. CXCVII. p. 627.

- I. **H**AVING since the publication of the foregoing letter, been commanded by the king, to show his majesty an experiment of the way herein mentioned; to examine the freshness and saltness of waters; I did in his presence (and that of his royal highness, his grace the duke of *Grafton*, and several persons of quality) make trial of it, both upon some water prepared according to the patentees way, and upon two or three natural waters, that were ordered to be brought. In all which trials (in some whereof his majesty, for greater certainty, was pleased to employ his own hands) the success was such, as moved him to vouchsafe the experiment the honour of his special approbation, and to give me an encouraging permission to communicate it, as a thing that may prove not unuseful to the publick. This I think fit to mention, not only to procure to my way of trying waters, the high advantage of a royal, and (on philosophical accounts) illustrious patronage; but that, if this method be found as beneficial as I wish it may, men may know, to whom they ought to acknowledge the early publication of it. This is all my haste allows me to premise to the account I am going to deliver of the way of trying waters hitherto spoken of: which account I shall set down, as I drew it up to be dispatched to a friend, in case I should have his majesty's permission to impart it to him.
- II. My way of examining the freshness and saltness of waters, though (because it is wont to be surprising the first time one sees it tried, and has had the luck to be much talked of in many good companies) it is thought to be an invention very difficult, to be either found out or practised, is yet really no such mysterious thing as men imagine it. And for my part, I hope it will be found much more considerable for its use, than I think it is for the degree of skill and sagacity, that was necessary to devise it. For when I remembered and considered, that (as I have found by various trials) divers metalline and other mineral solutions could be readily precipitated, not only by the spirit of salt, but by crude salt, whether dry or dissolved in water, it was no very difficult matter for me to think, that by a heedful application of the precipitating quality of common salt, one might discover, whether any particles of it, (at

* Which should have been to the worthy doctor *John Beal*, to whom the letter this paper refers to was written, but to the author's grief, and the great loss of the commonwealth of learning, he died before this paper was written.

least in a number any way considerable) lay concealed in a distilled water, or any other proposed to be examined.

To find whether I was not mistaken in this conjecture, as also because it is very convenient to be as little as one can confined to one material, I employed several drugs, and those not at all prepared by one menstruum, to make the intended discovery. And, though two or three of my other trials had successes, that I disliked not when I made them, yet that, which at length I pitched upon as the most certain, and which therefore I meant, when I had the honour to be sent for by his majesty about the patentees water, was that, which I think may be best understood, as well as recommended by this short narrative. III.

I took some common distilled water in glass vessels, that it might leave its corporeal salt, if it had any, behind it, and put into a thousand grains of it one grain of dry common salt: into a convenient quantity, for example, two or three spoonfuls of this thus impregnated liquor, I let fall a fit proportion, for instance, four or five drops, of a very strong and well filtrated solution of well refined silver, dissolved in clean aqua fortis; [for a shift, common or sterling silver will serve the turn: *] and I made the experiment succeed with spirit of nitre, instead of aqua fortis, upon which there immediately appeared a whitish cloud, which though but slowly, descended to the bottom, and settled there in a white precipitate. IV.

THIS experiment having been several times, for the main of it, reiterated with success, I thought fit to keep constant to the way of probation I made use of in it, (and which trials had recommended to me for between 20 and 30 years) though (by reason of some things, that haste forbids me to mention) I pitched upon this way without at all denying, that men of sagacity, especially if well versed in chemical operations, may upon the same ground that I went upon, find some other and cheaper ways, though scarce any more nice and certain of compassing the same end. V

AFTER what has been hitherto said, I presume I may seasonably proceed, to subjoin the four ensuing advertisements. VI.

AND first, I shall give notice, that to make the experiment rather severely, than at all favourably, there was usually taken somewhat more than a thousand parts of water to one of salt.

NEXT I observed, that having let fall a few drops of our metalline solution into the liquor obtained from the sea-water by the patentees way of sweetning it, there did not presently ensue any white cloud or precipitate, much less such an one as had been newly afforded by the water, that was impregnated with less than a thousandth part of salt. And if after some time there happened to appear, (for it is not absolutely necessary it should) a little cloudiness in this fictitious liquor, it was both slower produced, and much less than that, which appeared in the impregnated water. VII.

IX. THIRDLY

* This passage was deposited with the Secretaries of the Royal Society, *An.* 1683. sealed up, and opened since the author's death.

† VIII. And perhaps it may be proper, that I here observe (what is not wont to be taken notice of) that divers solutions of mineral bodies may be precipitated by dilution, that is, (to explain this expression) when the solution has time enough allowed to diffuse itself, through a great quantity of water, the saline parts are thereby so diluted and weakned, that they are no longer able to sustain the mineral corpuscles, they kept swimming before, but make with them, and the water, a confused and subsiding mixture, usually of a whitish colour. This may appear, when the butter of antimony, being put into common water, is thereby quickly and plentifully precipitated in the form of that white powder, that chemists (not undeservedly) call *mercurius vitæ*. To which I may add, that I have also produced a powder of that colour, by pouring into common water a strong solution of tin glass made in aqua fortis. And by the same way we have precipitated the tincture for solutions of the finer parts of julap, benjamin, true labdanum, antimonial sulphur, and divers other bodies made in vinous spirits. If it were not for this power, that water

IX. THIRDLY, the usefulness of this experiment is not to be estimated only by the examen, it helps us to make of dulcified sea-water, but much more by the estimate, that by its means may be made of natural fresh waters, whether springs, rivers, clouds, lakes, wells, &c. For it being generally granted, that those waters, *cæteris paribus*, are the best, as well for the wholesomeness, as divers œconomical uses, as washing, brewing, &c. that are freest from saltness, which is an adventitious, and in most cases a hurtful quality in waters; by our way of examining these liquors, a heedful eye may in a trice discover, whether there be any latent saltness in them, (as most waters imbibe from the soil they have traversed, or do stagnate in) and may enable one, especially by the help of a little practice, to give a near guess, how much one water is fresher than another, as I have purposely tried with pleasure in differing waters, that were ordinarily drank, even by considerable persons. And if once you have attentively marked, what change four or five drops, for instance, of our discovering liquor will make in two or three, or some other small determinate number of spoonfuls, (or rather of half ounces) of water; it will not be difficult for a heedful observer, keeping the same proportion between the two liquors, to make a near estimate, whether any natural water proposed to him have a greater, an equal, or a lesser degree of freshness or saltness, than that water, that he has chosen for his standard; and how much, in case there be a difference, the proposed liquor is less or more free from saltness than the other.

X. AND that (to add this by the by) such a difference in a liquor of such frequent inward use as water (which is the basis of beer, ale, mead, and some other common drinks) may have considerable effects upon human bodies in reference to health, may be probably argued from the differing effects, that waters more or less impregnated with salt have upon divers other bodies. Since most pump-waters, for instance, will not boil peas and beef, and some other aliments, near so well as spring-water or rain-water, which are usually softer, and more free from the saltness we speak of. It is commonly known to barbers and laundresses, that the same pump-water will not so well and uniformly, or without little curdlings, dissolve wash-balls and soap, as rain-water, and some running waters usually will: nay, when I was curious of tempering steel, I remember it was confessed by the skilfullest artists I made use of, that some tools, (as gravers, &c.) made of that hardest of metals, would receive a differing temper, if they were quenched in pump-water, from that, which the like extinction in spring water or river water, would give them. But how to make our estimate of the freshness or saltness of water come nearest the truth, is a problem, of which I have now neither time nor conveniency enough to deliver my thoughts. And by what has been said, I hope it does already seem sufficiently probable, that the way above proposed may prove of good use, both to navigators, that are often necessitated to water in unknown places, and to others, that only, or frequently drink that liquor, without having any better

has to weaken most solutions of bodies, I could have employed, instead of that silver, either quicksilver dissolved in aqua fortis, or lead crude or calcined in the same liquor, or (which is more convenient) in strong spirit of vinegar; since these, and some others, are found to be precipitable by salt water into whitish Powders. But though a very heedful observer may, for a shift, make use of these metalline solutions, to guess at the quality of water, as to freshness and saltness; yet the precipitation, that is made by dilution, is not difficult to be distinguished from that which is performed by a true and proper precipitant, (as in our case by the common salt, that is harboured in the pores of the water) both by the quickness of the effect, and the copiousness of the white substance produced, and on both those accounts is very much inferior to it, as may evidently appear in the very different effects, that our solution of—had upon the patentees water, or upon well distilled common water, compared with those it had upon water impregnated with a thousandth part of salt, and upon divers common undistilled waters. This advertisement I have placed in the margin, as not thinking it fit either to omit it, or by inserting it in the body of the writing, to give too great an interruption to the series of my discourse.

way than the taste, (which is but an incompetent one) to estimate its freshness and saltness by*.

FOURTHLY (and lastly) though both in my letter to Dr. I. B. and in this present postscript, I did not for certain reasons ascribe to our method of examining waters, a greater nicety, than to be able to discover one part of salt in a thousand of water, that proportion being great enough to recommend it, and expressed by a round number easy to be retained in one's memory: yet I would not have it thought, but that, if it were requisite, our method may make more nice discoveries. For having sometimes, for curiosity's sake, put one grain of salt into no less than fifteen hundred of distilled water, we could manifestly, (though not quite so conspicuously as before) make it appear by our way, that even this so lightly impregnated liquor was not devoid of salt, but had more of that in it, than some of the patentees water, that I kept by me, had; nay, I once found, that a grain of dry salt, being dispersed through two thousand, and another time, that being dissolved in three thousand times its weight of the same kind of liquor, so inconsiderable a proportion of salt was plainly discoverable by our precipitant.

XII.

BUT here philosophical candour forbids me to conceal an objection, that I made to myself, though it be the chief, if not the only considerable scruple, that occurred to me about our way of examining waters. For I foresaw, that it may be objected, that, whereas the experiments hitherto mentioned have been tried only upon waters impregnated with gross or corporeal sea-salt, this perhaps may not hinder, but that they may be imbued with the spirits of marine salt, which, by reason of their activity, may be as unhealthful to the drinker, as the grosser salt itself. But though to this surmise I might answer, that a very small proportion of spirit of salt may in many cases make the water seasoned with it, rather medicinal than unwholesome; yet I shall answer more directly to the objection, by saying, that to manifest its not being well grounded, I took above a thousand grains of distilled water, and instead of corporeal salt, put to it one single drop of moderately strong spirit of salt, (for I had much stronger by me, that I purposely declined to employ) and having shaken it into water, I let fall into a portion of this unequally composed mixture some drops of our solution of silver, which presently began to precipitate in a whitish form; insomuch, that, for ought appeared to the eye, this trial succeeded better, than if the water had been impregnated with but a thousandth part of corporeal salt. The like experiment was made with the patentees water instead of the other. And to pursue this trial a great way farther, I had the curiosity to diffuse one drop of spirit of salt into two thousand grains of distilled rain water; and upon letting fall some drops of our precipitant into it, I found, that the success well answered my expectation. And then, to urge the trial yet farther, I added as much of the same distilled rain water, as by a modest conjecture

XIII.

* XI. I might add on this occasion, that, whereas experience has informed several persons, who have consulted it, that divers medicinal waters, that are presumed to owe their virtues to the participation either of metalline, or of other mineral bodies, do upon trial appear to leave sometimes little, and sometimes nothing behind them, except a kind of common salt; our precipitant may much assist men to discover, whether a mineral water, proposed to be examined, do or do not contain such a salt, and if it do, whether it contain it copiously or no. This I have tried upon more than one of our English mineral waters, and thereby found in a trice, that one, that is reputed of another nature, contained pretty store of saline matter: and that another (which is still, for ought I have learned, of an unexamined and unknown nature) is impregnated with a surprising plenty of saltish substance. But how and with what cautions our precipitant may be the most usefully employed about the examen of medicinal and other mineral waters, belongs not to this place, (but to another.) Upon which account I forbear to declare the use I have sometimes made of our precipitant, in examining the fresh urine of men, the serum of human blood, and other bodies belonging to what the chemists call the animal kingdom.

† About the examen of mineral waters.

made it amount to at least as much more. So that one grain of spirit of salt had a manifest operation, though not quite so conspicuous as the former, upon above three thousand grains of water, whose immunity from common salt we tried apart; and possibly, if the vial could have contained more, and would not have been, when filled, too heavy for our tender ballance, the discolouration of the mixture would have been discernible, though but one grain of spirit of salt had been put upon four, or even five thousand grains of water. And that a drop of the saline spirit we made use of, did not equal in weight a grain of dry salt, I found by this, that having let fall into a counterpoised piece of glass ten drops of that spirit, I found them to want near half a grain of nine grains weight; which way of estimating I chose, as less subject to any considerable error, than that of weighing a single drop by itself.

XIV. THE like trial I made by substituting above a thousand grains of rain water, in the room of the like quantity of distilled water. And these two experiments I the rather mention, because they do not only show, how free the patentees water was from spirituous, as well as from corporeal sea-salt: but also manifest, that, whereas it is the opinion of some seamen, and of a person, for whom I have a profound respect, that water ought to have a little saltishness to preserve it; if this be really a desirable quality in our artificial water, it may in a trice be supplied with as much saltiness, whether corporeal or spirituous, as shall be required, and consequently as will bring it to be equal in that quality to the common water of rivers, or of springs. And perhaps it will not be impertinent to add on this occasion, that in some places, especially lying in hot climates, it may sometimes be of good use to know, whether on the account of the sun's heat, or that of the subterranean regions of the earth, the rain water is impregnated with volatile (not acid) spirits, like those, that are distilled from urine, and which I have, for curiosity's sake, obtained from a mineral body, native sal-armoniac; upon which account I made a trial, that informed me, that if five or six drops of strong spirit of urine (whose drops I observed to be but small) were shaken into a thousand grains at least of distilled or rain water, impregnated with but one of salt, our precipitant would make a discovery of some saltishness in the liquor. And it were neither to be admired nor censured, if the patentees water should sometimes show a change, when our precipitant is plentifully put or long kept in it, especially that change being a more light one, than that I came from speaking of; since, for ought I have yet observed, not only such undistilled waters as are generally allowed to be freely potable, but even those, that nature herself distils, are not always quite devoid of saltiness. For I have found rain water, that I caused to be carefully saved, after the housetops had newly been well washed with former rain, to grow a little troubled, if any store of our precipitant were kept for some competent time in it. And being gently distilled off, it left a residue, which with a little of our solution afforded a far more suddenly made and copious precipitate, than had been produced with the like quality even of pump-water itself. And, though I have met with rain water, that was more free from salt than any spring or river-water, that I remember I have examined; yet having, for curiosity's sake, made a trial of snow-water, (which if the weather had been somewhat milder, would have been rain) this liquor, I say, which is thought to afford the lightest water of all natural ones, I manifestly found, by our way of examining it, not to be devoid of saltiness.

XV. BUT to return to the trial we made with the spirit of salt, these experiments may not a little confirm the patentees water. And whereas some have either really suspected, or invidiously pretended, that even a moderate action of the fire upon water, will make it brackish and putrify; as I see no substantial grounds of this surmise, so it appears by the foregoing trials, that really the patentees water is not brackish, but is more free from saltiness, than most of the waters men do without scruple drink. And if it

were true that this water should not keep quite so long as others, yet that were no more than is objected (how truly I now enquire not) to the generality of distilled waters: and that this we speak of may keep sweet longer than is necessary in a ship, that can from time to time, within a few days, supply itself with fresh out of the sea, may be gathered from these two things. The first is, that to satisfy myself, whether closeness would make the prepared water soon putrefy, (as seemed obvious to be surmised) or at least afford dregs, I caused a pint, or a pound of it, to be hermetically sealed in a vial, whereof I left by guess about a third part empty; and having above six weeks after held this vessel against the light, I found the water to be clear and limped; though I did not judge it had deposited so much as the tenth part of a grain of feculency. And having opened the seal, and taken out a little of the liquor, I did not find it altered, either as to smell or taste. The second of the two things, that were to be mentioned, is, that I have kept the bottle of prepared water mentioned in my letter to Dr. Beal, in the same unstopped vessel ever since *March*, that is so long, that it is near eight months old, and yet it continues sweet and well conditioned. And if that, which is called crudity in water, does consist (as probably it oftentimes does) in certain gross particles, that are mingled with the purely aqueous ones, it is likely, that the action of the fire may divide and dissipate these into minuter particles, and thereby destroy the texture, that makes them hurtful; and by causing innumerable tumblings and roving among the more earthy particles, give them opportunity to make little coalitions, whose weight precipitating them to the bottom frees the pure water from them.

AND because it is but too probable, that the unwholesomeness of divers waters proceed, not only, or perhaps not so much, from bare crudity, as from a great quantity of grosser particles, that are not easy to be raised, because of their being combined with fixed and earthy ones, that swim up and down in the water they impregnate, as silver or mercury does in a solution made with aqua fortis, or rather as the particles of salt do in pump-water, and many other common waters; on this account, I say, the patentees invention may very much correct such waters, since by their way of sweetning those liquors, the truly aqueous parts are not only freed from the saline ones, but from the mineral, and other gross and hurtful corpuscles, that may have lain concealed in the liquor. As may be argued from hence, that having purposely in the gentle fire of a digestive furnace slowly distilled off a pound of the patentees water, it left us in the cucurbit so light and thin a feculency, that the bottom of the glass seemed to be rather sullied than covered by it; and I did not judge, that the whole feculency, if we could have got it out, would have amounted to so much as two grains.

XVI.

BUT to return, after this short, and I hope not impertinent digression, to what I was lately saying of the virtue of the fire, to correct the crudity of waters, I shall proceed and say, that perhaps it was upon some such reasons, (to which others might be added, if I could in few words confirm paradoxical ones) that the last great duke of *Tuscany*, when he drank water, (for it was not, as I perceive some have misunderstood, his only drink) preferred, for wholesomeness, that, which was distilled, to that which was not; and if herein that learned prince, and those of the same opinion, were not mistaken, it will highly recommend the usefulness of the patentees invention to mankind: for I shall on this occasion observe, that there are multitudes of waters, that are not considerably brackish to the taste, that yet, by reason of some unheeded saltiness, as in most pump-waters, are more frequently, by reason of crudity, not only unfit, or (at best) less fit, for divers oeconomic uses, as washing, boiling of some meats, &c. but are very unwholesome; sometimes to a degree, that makes them mischievous to whole communities, and perhaps nations. Of this it were to be wished, that it

XVII.

were

were harder to give instances. I remember I have seen a notable one, in those high and unsightly tumours about the throat, which are observed by travellers to be exceeding common among those, that inhabit the lower tracts of ground, that lye between the Rhætian, Helvetian, and some other neighbouring mountains; which monstrous swellings are generally imputed to the snow-waters, that flow from the mountains, and make the usual drink of the meaner sort of people; whence it is observed that persons of better condition, who drink wine more than water, are either not at all or far less troubled with these disfiguring *goitres*, (as they call them.) But much more notable instances to our present purpose are afforded me by that great (and yet living) traveller, monsieur *Tavernier*, baron of *Aubonne*, who speaking of a nation of Cafres or negroes, that comes sometimes to trade with the Portuguese from a remote part of *Africk*, informs us, that the water of their country is very bad, which is (says he) the reason that their thighs do swell, and it is a wonder to see any one of them free. Nay, which is far more, where he speaks of the African kingdom (or empire) of *Monomotapa*, he has this memorable passage, “the natives never live long, by reason of the badness of the waters in the country. For at the age of twenty-five they begin to be dropsical, so that it is a great wonder, if any among them live above forty years.”

Tavernier's travels, part II. book II. chap. 23. page 156.

XVIII. WHAT monsieur *Tavernier* delivers being taken for granted, it seems very probable, that these people may be much relieved, and be brought to live as long as other nations, if they had so compendious a way as that of the patentees, to provide themselves plentifully with water, whose crudity is corrected, its grosser and heavier parts separated, and its brackishness destroyed by the fire, as its action is regulated and helped by their invention.

[THE experiment mentioned in this paper was tried at a meeting of the Royal Society, February 17, 1691-2, by Dr. *Sloane*, with a success answerable to the assertions of the honourable author, and that a drop or two of spirit of salt mixed with common water would be by the same method discovered.]

END of the FIFTH VOLUME.

